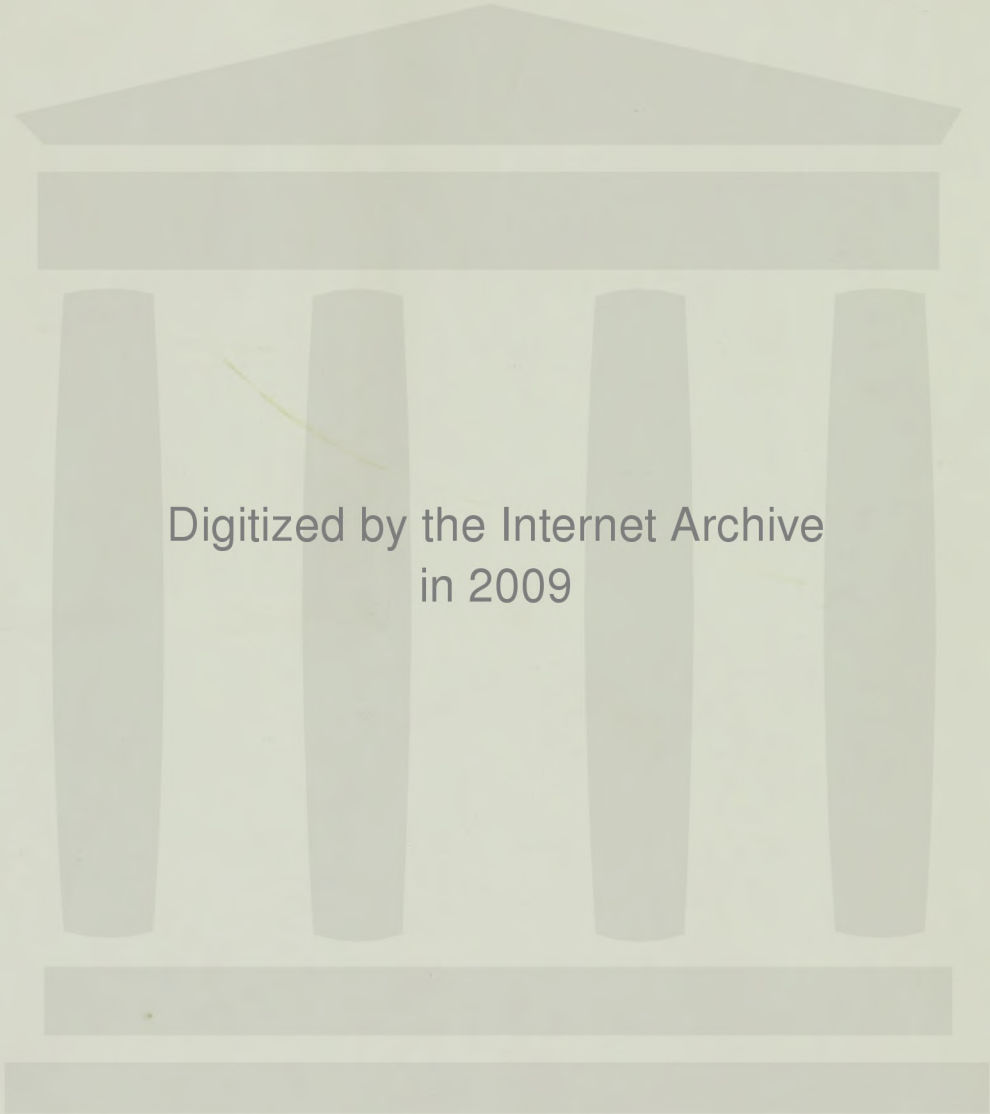
THE STRANGE WORLD OF DINOSAURS

BY DR. JOHN H. OSTROM

ILLUSTRATED BY JOSEPH SIBAL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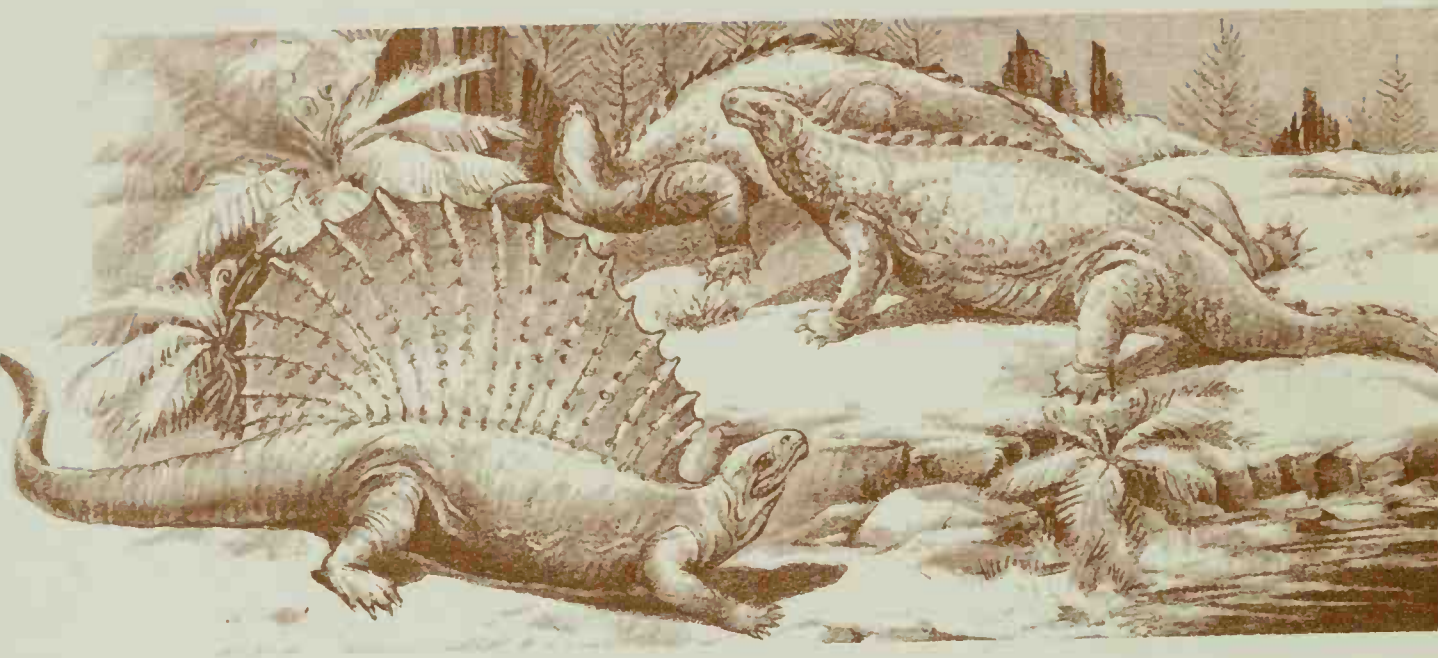
THE STRANGE WORLD OF DINOSAURS

No one knows for sure whether the creatures of the Age of Reptiles were vivid purples or quiet grays, but other than determining colors, paleontologists have succeeded in putting together the story of the dinosaurs. *The Strange World of Dinosaurs* tells how the detection begins with fossil hunting, and pictures the different families and species in their various habitats. Over one hundred halftone illustrations complement the text.



Also illustrated by Joseph Sibal

The Strange World of Reptiles
by James Norman

The Strange World of Insects
by George S. Bush

THE STRANGE WORLD OF DINOSAURS

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MAY 1972
CITY & COUNTY OF DENVER

By
DR. JOHN H. OSTROM

Illustrated by
JOSEPH SIBAL

G.P. PUTNAM'S SONS NEW YORK

To my daughter, Karen

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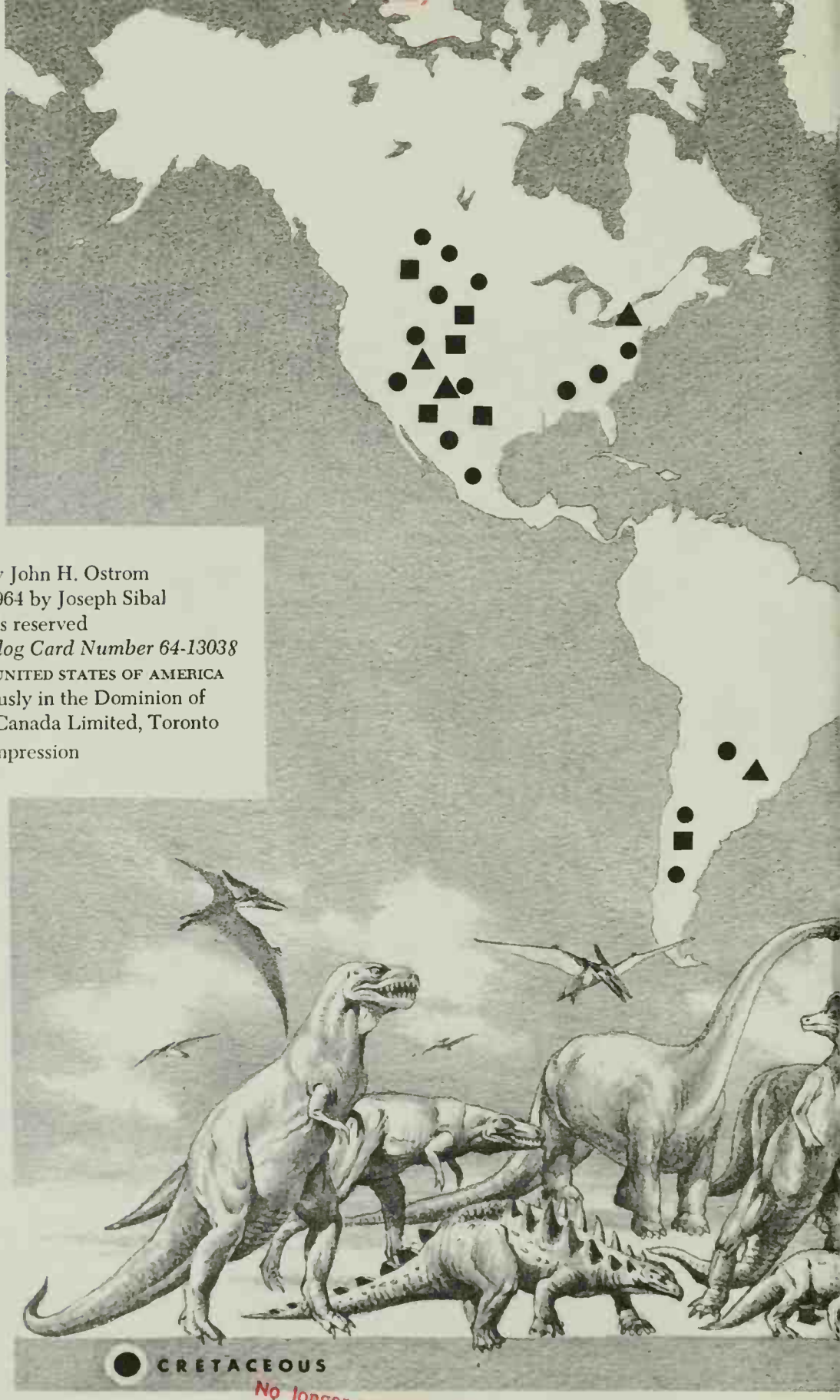

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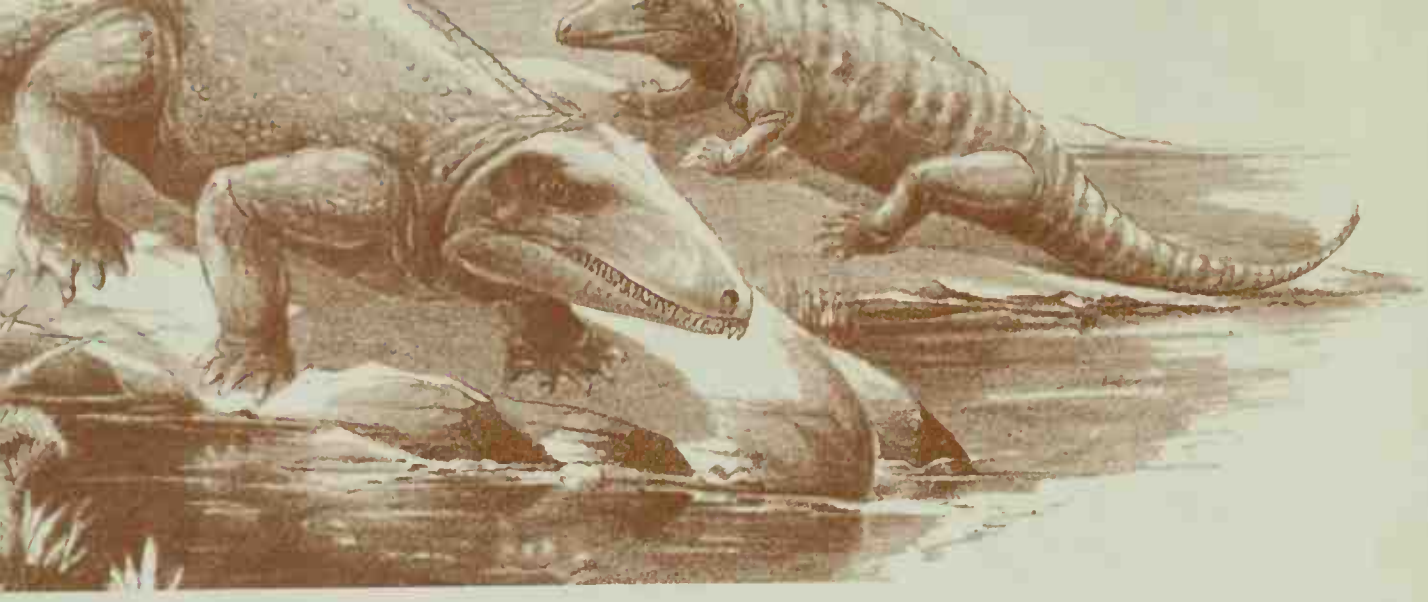

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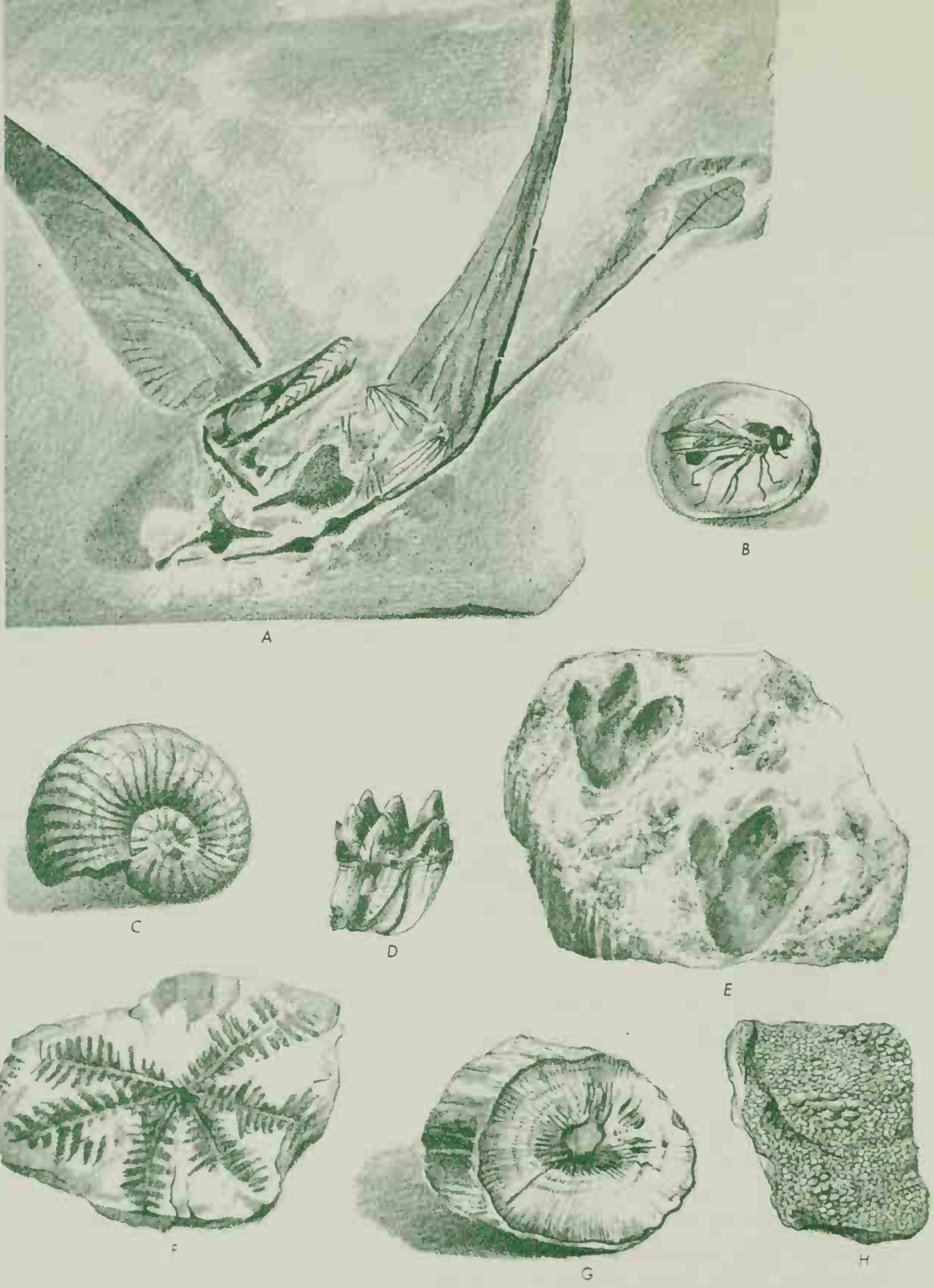
1

Who Finds Dinosaurs?

EVERYONE, EXCEPT Alley Oop that is, knows that the dinosaurs are extinct. The story of those strange and sometimes giant animals of long ago is a fascinating story. It is a story which has aroused our curiosity and stimulated our imagination for many years. The huge dinosaur skeletons in museums all over the world are part of this story and they never fail to impress us. What did these monsters really look like? Were they as fierce as we imagine? Or were they timid? What noises did they make? Where did they come from and where did they go? Why did they all disappear? These and many more questions like them run through our minds as we stand looking up at their petrified skeletons in museums, or as we look at pictures of them that artists have drawn for us. Each of us wonders, what were dinosaurs really like – and how did they live?

These are all parts of the strange world of the dinosaurs – a world of long ago that is described in these pages. But this book can tell only part of the dinosaur story, because there are still many things we do not know about them. We know, of course, that there were many different kinds of dinosaurs – many of them very large, but others quite small. Some of them were meat eaters, but most were plant eaters. And each of us knows that all of the dinosaurs became extinct, although we are not able to say exactly why. In fact, to many people the word *dinosaur* has come to mean the same thing as failure, because these animals all died out. But this is completely



A — Fossil Pterosaur. *B* — Insect in amber. C — Ammonite. *D* — Mastodon tooth. *E* — Dinosaur footprints. *F* — Impression of fern. G — Petrified wood. *H* — Dinosaur skin impression.

wrong. The dinosaurs were not a failure; in fact, they were a big success because they survived and ruled the earth for many millions of years, at least 100 times as long as man has.

Scientists on every continent are still searching for undiscovered dinosaurs and other strange animals of the past, for it is clear to us now that we have not yet found all the different kinds of animals that lived in the world of long ago. Scientists are constantly seeking answers to the questions we have just asked and to many other questions like them. Indeed, the world of the dinosaurs is strange and it seems mysterious and a little frightening to us – and we are perhaps relieved that there are no dinosaurs wandering about the earth today.

Fossils and how they happen

Dinosaurs died out a very long time ago, so we can learn about them only by their fossil bones that have been left behind and preserved for us by accidents of nature. The bones and shells of ancient animals are called fossils, as we all know. A fossil may be a piece of bone or a whole skeleton, or it may be a clamshell, or the imprint of a leaf, or a starfish. It might also be the footprint of a dinosaur, or the tusk of a mastodon. All of these are clues about some kind of ancient animal or plant that lived long ago before any of us were born.

How are fossils formed? Well, there are many ways, but most often it happened when a dead or dying animal or plant was buried by mud or sand. Sometimes the bones of an ancient animal were covered over by sand or mud that was being deposited along the shores or in the bottoms of rivers or lakes. Other times animals were trapped and died in swamps or bogs and were buried there. Very slowly this mud and sand became hard and turned to rock. The mud became a rock that earth scientists call shale, and the sand changed into sandstone. But, of course, this did not happen every time an animal died. Most often, the animal was not buried, so the flesh and bones decomposed and were not preserved as fossils. It is only very rarely that bones or shells are buried so that they can be preserved and it is even rarer for them to be discovered and collected.

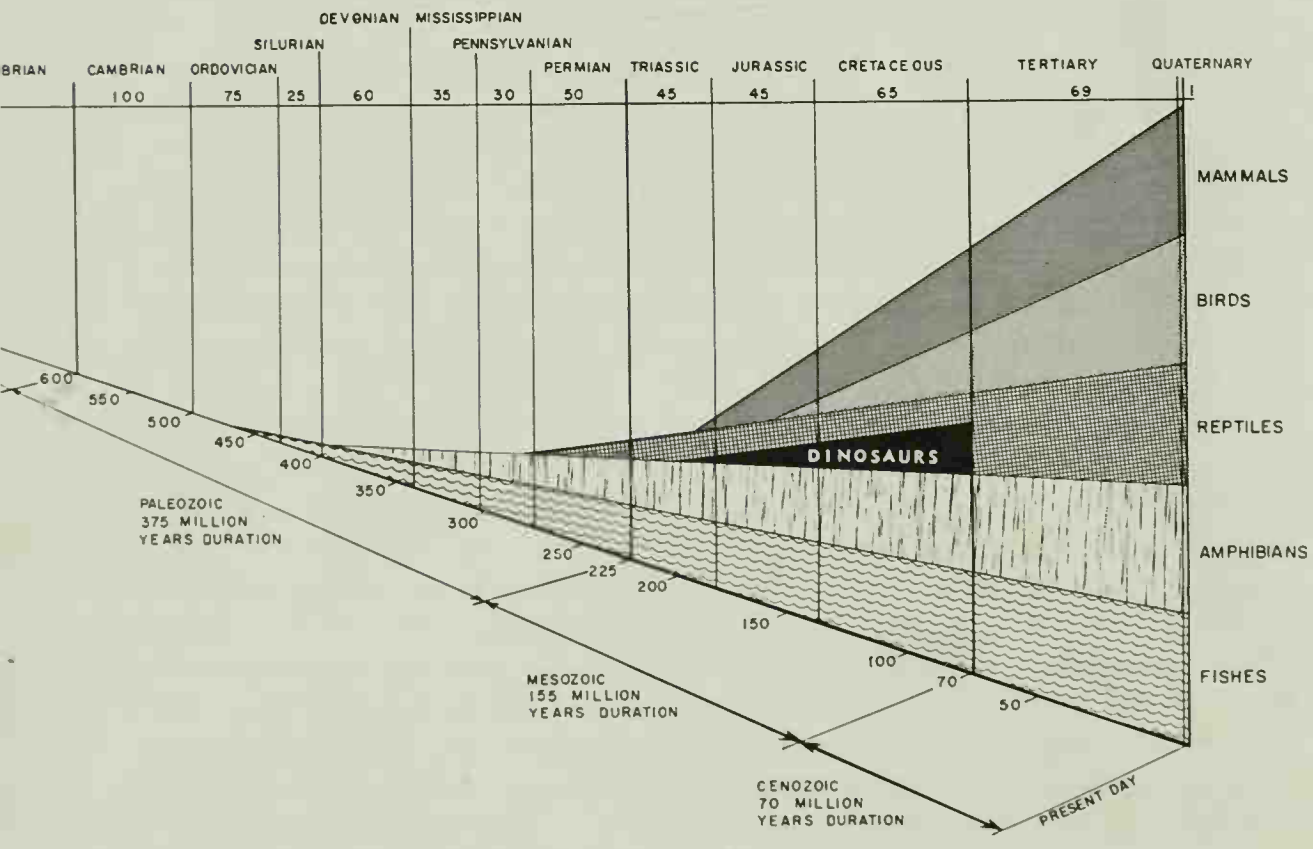
When fossil bones or shells are discovered in sandstone or shale, they are often very hard and heavy. This is because while they were buried in the rock, minerals were deposited in and around them. They became mineralized or petrified. In other words, they too turned to stone, just as the shale or sand around them. These minerals are deposited very, very slowly from the water which seeps through the hardening mud and sand. Of course this takes a very long time – so long, in fact, that it is very difficult for us to imagine how long. It is important for us to understand how slow this process is and just how long ago these bones were buried. To do this, we must talk about time for a moment. Only now we will talk about geologic time – the time span that covers the whole history of the earth and all the animals that once lived but have long ago died out.

Geologic time and the age of the dinosaurs

You and I measure time by hours and minutes and each of us understands how long a day or a week is. But the dinosaurs lived millions of years ago, long before there were clocks or calendars. Yet even then there was time. The days went by and year followed year. The very first of the dinosaurs lived almost 200 million years ago and the last dinosaurs died out about 75 million years ago. That is so long ago we can't really understand it. But perhaps if we use our imagination a little, we can learn and understand how much time has passed since the dinosaurs ruled the earth. So let us imagine a time machine that will take us back to the age of the dinosaurs.

Let us pretend that when we get into our time machine, it will take us back in time at the rate of one year every second. In other words, if we ride our time machine for only one minute, it will carry us back to the beginning of this century, about the year 1900. We have a long trip back to the last of the dinosaurs — 75 million years.

Our time machine seems to be going very fast at the start of our journey, but after a few minutes we begin to realize how long ago the last of the dinosaurs lived. In fact, it will take us more than two years to make our trip. Two years, four months,



GEOLOGIC TIME TABLE — PERIODS SHOWN IN MILLIONS OF YEARS

and 18 days! Only after that long ride will we be able to look out of our imaginary time machine and see Tyrannosaurus and perhaps Triceratops.

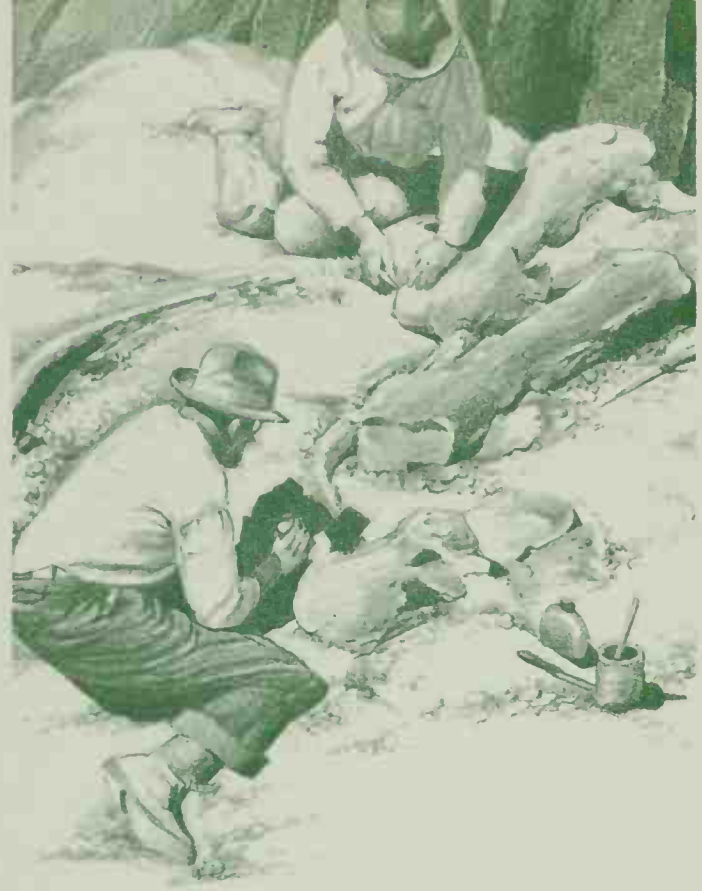
And what about all those dinosaurs that lived before Tyrannosaurus and Triceratops? When did the very first dinosaurs live? Well, if you want to see them, we must hop back into our time machine. We have an even longer journey ahead of us. We must travel for almost four years more before we are back to the time of the earliest dinosaurs that lived nearly 200 million years ago. And remember, when we reverse our time machine to bring us back to the present, we are in for nearly six and a half years of continuous traveling! Two hundred million years is a very long time.

Earth scientists or geologists have not always been able to tell how many years ago the dinosaurs lived. Only recently did modern science uncover the secrets of radioactive materials that enable geologists to measure this time – even back to thousands of millions of years. By use of these radioactive "clocks" scientists are now able to measure the age of the earth with pretty fair accuracy, and it is certain that the earth has been here for nearly 5,000,000,000 years (5 billion years). But before the atomic age, we could only make educated guesses about the age of the earth or about how long ago dinosaurs walked the lands. So geologists had to set up a different kind of time system. This is usually called the geologic time scale, but we might call it a geologic calendar or a chart of earth history. It is based on the many layers of sandstone, shale, limestone and other rocks that have been laid down in the earth's crust during earth history. The total time of earth history, even though the exact number of years wasn't known, was divided into periods of time – just as human history has been divided into periods of ancient history, medieval history, and modern history. This geologic time scale is shown on the chart here. As you can see, there are thirteen major periods of earth history shown in this chart. Geologists might have chosen more, just as historians might have chosen more periods of human history, or just as our calendars might have been made with more or less than twelve months. For example, our calendars might have only four months in a year – one month for each of the seasons. The number of months or periods in a calendar is not important. What is important is that we know the order in which the periods come and that we all agree to use the same calendar and that the months or periods of that calendar are defined in the same way by everyone.

The Pre-Cambrian period is the oldest and also the longest period of earth history. After that came the Cambrian period and then the Ordovician, and so on. You and I are living during the most recent period of earth history – the Quaternary period. The Triassic, Jurassic and Cretaceous periods are of the most interest to us at the moment, for these are the periods when the dinosaurs roamed the earth.

Searching for dinosaurs

The first question usually asked of a dinosaur hunter is: How do you know where to dig for dinosaurs? Or: How do you find dinosaurs? The search and discovery, of course, is one of the most exciting things about studying these ancient animals. We



Left, scientists carefully clean fossils on or near the site where found. *Above,* strips of burlap soaked in plaster of Paris are used as protective covering on large fossil bones.

never know when or exactly where they will be found. But all fossil hunters have studied earth history. They are well acquainted with the many kinds of rocks and they know that dinosaurs are found only in certain kinds of rocks. Once the right kind of rock has been located, the search is on. The fossil hunters then start walking across the countryside, following the proper layers of sandstone or shale. Their eyes are glued to the ground. They walk and look, look and walk, searching mile after mile. They are looking for any little sign of fossil bone. Then, after what seems like hours and hours of walking, a piece of bone is spotted – down there at the bottom of a small hill. Of course that bone fragment must have rolled down from somewhere higher up on the hill. Slowly, looking over every inch of ground, the fossil hunters work their way up the slope. A few more pieces of bone are found by the sharp-eyed hunters. Then what looks like a whole bone is seen sticking out of the rock of that hillside. The discovery has been made! Now to see what kind of animal has been found.

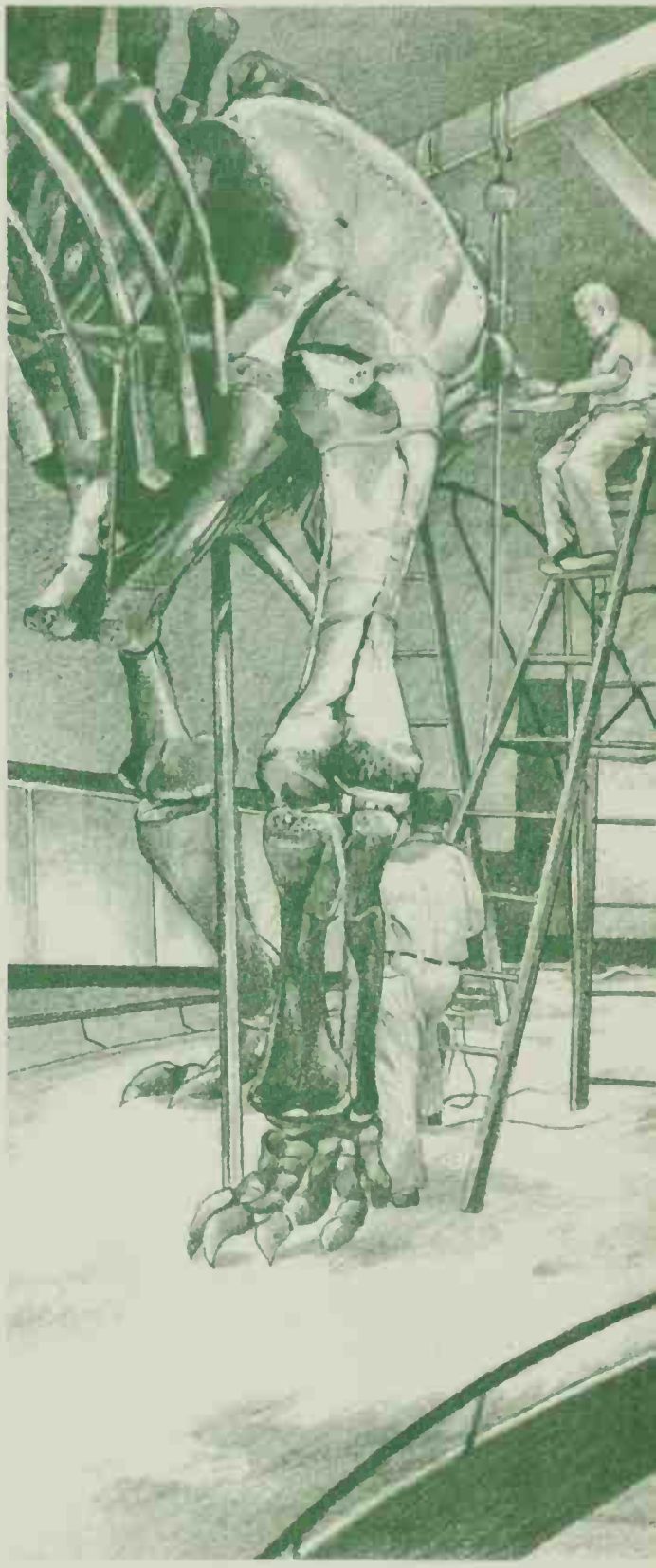
A discovery like this is the reward for all the walking and searching, but now the really difficult and slow part of the job begins. The bones must be dug out of that solid rock. Sometimes shovels and picks can be used and once in a while dynamite may be used to loosen the overlying rocks. But most of the time it is a job for hammers and chisels and whisk brooms. The rock is chipped away until each bone is

uncovered. Often a whole slab of rock with many small bones is chiseled out. Other times, the larger bones are taken out separately. Once they have been removed, the bones or slabs of rock must be packed and crated to protect them from being damaged. This is often done by bandaging the bones in burlap and plaster. When they are all bandaged and crated, they are ready to be shipped back to the museum where they will be prepared for study and exhibit.

Cleaning and repairing dinosaurs

After the excitement of discovering a dinosaur skeleton, the scientist who studies dinosaurs is faced with the long and difficult task of preparing the bones for study and display. Each bone must be carefully cleaned of all the rock that covered it. This can be very tricky, because the rock is usually very hard but the bones may sometimes be quite soft. By working most carefully with small chisels and brushes, all of the rock is finally removed. At times, some of the bones may be broken either as a result of the crushing weight of all the sediments that buried them, or through the process of digging them out. In such cases, the scientist must mend each broken bone. This is rather like putting together a three-dimensional jigsaw puzzle.

When the bones are repaired and cleaned, the final job is to put all the bones together again just as they were in the living dinosaur. In order to do this, each and every bone must be identified so that it can be put in its proper place in the skeleton. The scientists who put these skeletons together have much experience. They have no trouble tell-



Assembling and positioning fossils in a museum is heavy work, yet delicate work.

ing neck bones from tail bones or arm bones from leg bones. It's only when some of the bones are missing that paleontologists (pail-ee-on-TOL-o-jists) have trouble building the skeleton. A paleontologist is the scientist who studies fossils and the subject of paleontology is the science of ancient life.

Mounting a dinosaur skeleton in a lifelike position might seem like great fun to you, but let me tell you that it is hard work. Remember, most of the dinosaurs were very large animals. Even the smaller ones were as large as cows or horses. And also, these petrified bones are very heavy. Steel pipes and frames must be put together to support all that weight and to hold the bones together. In mounting the skeleton of Brontosaurus, great steel beams are needed. These must be welded together by a welder and only then can the bones, which weigh as much as 200 or 300 pounds each, be lifted and fastened into place. Some bones, like the leg bones of Brontosaurus, weigh almost 1,000 pounds. For these, powerful machines are needed to lift them so they can be fastened securely to the steel beams. It is a hard job that requires many men working weeks and even months to finish.

What did the dinosaurs look like?

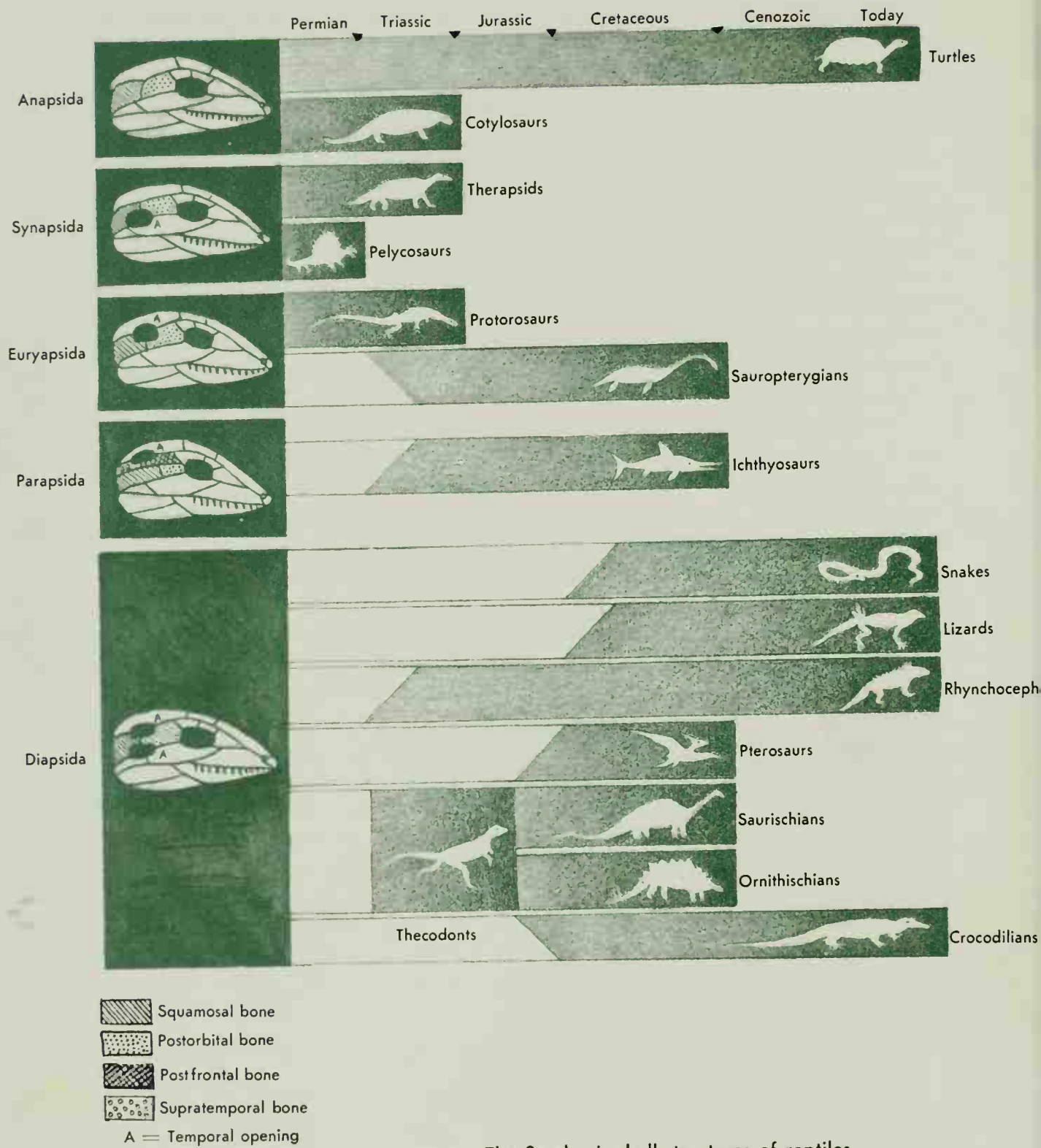
Here is another question that is often asked of paleontologists. The pictures that you see in this book are part of the answer to that, and as you read on about the dinosaurs you will learn other things about how they looked. Another important question is: How can you tell that the dinosaurs looked this way? Both of these questions are difficult to answer completely, because of course no human being has ever seen a live dinosaur. But scientists are able to reconstruct their general appearance. How can they do this? The answer is, by their knowledge of anatomy. For example, each bone of your body has a number of muscles attached to it. These muscles are arranged in certain patterns so they can move the parts of the body. In your leg, there are several muscles that you use to bend your knee. There are several other muscles in a different pattern that straighten the knee. Muscle arrangements like these are also found in a dog's leg and in that of a lizard as well. There are some differences, of course, but the basic pattern is much the same. If you will look at the skeletons of several different kinds of vertebrate animals you will see that there are similarities between them in the arrangements of the bones, too. By knowing these patterns and bone arrangements, the muscle patterns of the dinosaurs can be reconstructed. And once the muscles have been restored, we have a pretty good idea of the shape of the animal. All that is needed now is to cover our reconstructed dinosaur with skin.

Another clue to dinosaur muscles can sometimes be seen right on the fossil bones. Some muscles have left scars on the bones. These show where the muscles were attached and give us some idea how large the muscles were. In such cases, the scientist can be more certain of the muscle patterns and we can be more sure of how

the dinosaur originally looked. You can see, then, that dinosaur reconstructions are not just guesswork. They are based on a good knowledge of animal anatomy. And the pictures you see here give a good idea of how these prehistoric animals looked.

But there are still certain things that we cannot learn about dinosaurs. One of these is their color. What color were the dinosaurs? Were they brightly colored or were they dull? Could they have been spotted, or striped, or just plain? These things we can never know for certain, because color is not preserved in fossils. By looking at living animals, though, we get an idea. Some modern reptiles are quite dull in color, but some are very brightly colored. Others are striped, or spotted, or have a more complicated pattern of colors. And of course some are just plain, without any pattern at all. A good guess then would be that dinosaurs came in all colors and patterns. We have no reason to think they were colored in any special way, so it seems likely they were colored much as modern reptiles are. But this is only a guess and we will never really know.

"*Where are dinosaurs found?*" is another question asked of paleontologists. They are found in many places. Dinosaurs have been discovered on every continent of the world, but they have been found most often in North America, Europe, Africa and Asia. Our own North America is probably the most famous land of all for dinosaur discoveries. Where in North America? Mostly from our western states of Montana, Wyoming, Utah, Colorado, New Mexico, Arizona, and Texas. But dinosaurs have also been found in Connecticut, New Jersey, North Carolina, Alabama, and in many other states. And in Canada, the provinces of Alberta and Saskatchewan are very famous for the dinosaur discoveries made in those areas. We can be sure, then, that dinosaurs roamed over most of this land we now call North America. And we know that they roamed over much of Africa and parts of Europe and Asia. As you read on you will learn more about where the various kinds of dinosaurs lived.



The five basic skull structures of reptiles.

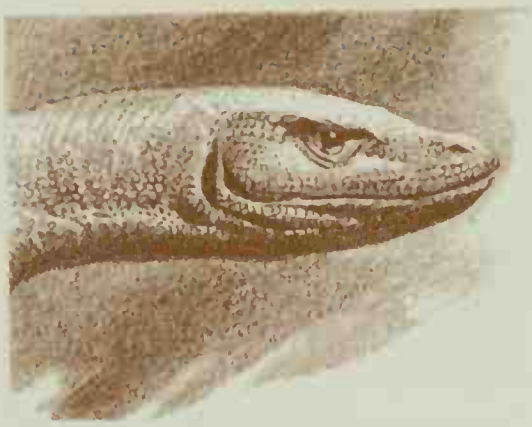
2 The Animal Kingdom

BEFORE WE START reading about the dinosaurs, we should find out something about the many different kinds of animals. Only then can we begin to really understand the dinosaurs and where they came from. So let's sort out some of the many kinds of animals and see where the dinosaurs fit in the animal world.

Within the animal kingdom there are many different kinds of creatures. They range all the way from the smallest bacteria that can be seen only through a microscope, to the largest of whales. We might sort out animals according to size, but a better way is by their anatomy – by the way animals are built. When we do this, it is clear that there are two main kinds of animals: those with backbones and those without. Examples of some animals without backbones would be insects, crabs, clams, starfish, squids, and many others. But we are more interested here in those animals that have backbones, such as horses, cats, frogs, birds, and the many kinds of fish. The backboned animals are called the vertebrate animals. The word vertebrate is taken from the scientific word for the bones of the back, which are called vertebrae. Those animals without backbones are called the invertebrate animals.

As we know, there are many kinds of vertebrate animals and these too can be sorted out according to their anatomy. First of all, there are the fish – the many thousand kinds of fish. Then there are the amphibians – those animals which can live either in or out of water. Amphibians that are familiar to us are the frogs and toads and the several kinds of salamanders. A third kind of vertebrate animal is the reptile. We are all acquainted with these scaly and cold-blooded creatures, such as turtles, lizards and snakes, and the larger crocodiles and alligators. But did you know that

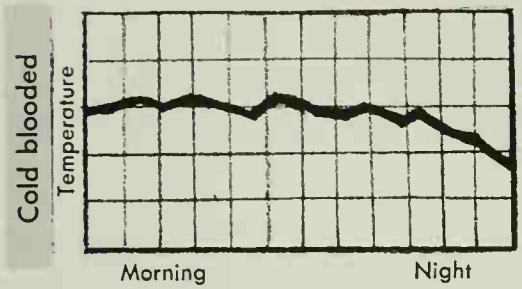
Reptiles



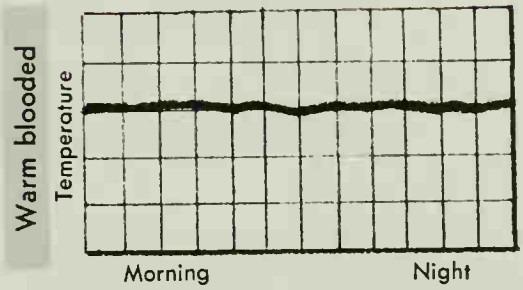
Scaly skin

Mammals

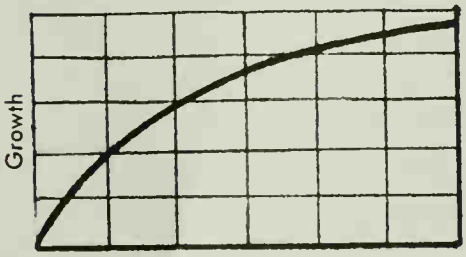
Hair or fur



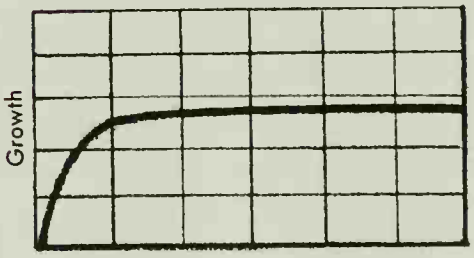
Varied temperature



Even body temperature



Continuing through life



Limited

Hatched from egg
No care of young

Born alive
Mother care for young

Character comparisons of reptiles and mammals

these modern reptiles are related to the long-extinct dinosaurs? The dinosaurs were also reptiles.

There are two more types of vertebrate animals that we haven't mentioned yet — the birds and mammals. Our feathered friends are probably the most familiar and popular of all the animals. Feathers, by the way, are the main characteristic of birds. It is not because they fly that they are classified as a separate kind of vertebrate. You may recall that not all birds can fly, but all birds do have feathers. Mammals include all of the fur-bearing, warm-blooded animals. Animals such as the elephant, the cat, the dog, the mouse and you and I are mammals. A look at the chart here will show you how the vertebrate animals have been classified or grouped together.

Evolution of animals

Scientists have long known that animal kinds change with time. This change takes place very slowly over many thousands or millions of years. Animals that we see today have descended from animals of long ago. But over thousands of years these animals have changed, so the animals of today do not look exactly like their ancestors of the past. This is why many of the animals of the past look so strange to us. Scientists call this gradual change evolution. Because of evolution, we can expect that animals millions of years from now will look very different from the animals of today. In other words, the animals we see now have evolved from ancient creatures, and the animals of the future will have evolved or descended from those of today.

Let's look at a few examples to help us understand this better. We can all tell the difference between lions, tigers, leopards, pumas, and our own little house cat. They differ in color, or in having stripes or spots, or in being small or large. These are small differences that help us to tell these animals apart. But these differences do not hide the fact that they are all cats. And being cats, they are all related to each other. They are descended from the same ancestor — some ancient catlike animal. This is why they all look like cats. But they do not look exactly alike because each kind of cat has changed or evolved in its own slightly different way and has thus become different from the others.

The same is true of the doglike animals. There are, of course, the many different kinds of household pets, like the collie, the setters, and the cocker spaniel. But there are other doglike animals too — the wild dogs, wolves, coyotes, jackals, and several kinds of foxes. As with the cats, we can see differences between these animals. Yet they all look doglike to us. That is because they are related to each other and are descended from an ancient doglike animal. But again, as was the case with the different kinds of cats, the doglike animals have changed in different ways so they no longer look just alike.

This slow process of evolution has produced all of our modern animals from animals of long ago. When we understand this slow change, we can then group or classify animals correctly and more easily. Then we can see that animals like the

porpoise and the whale are not related to the fish that they seem to imitate. They have hair and are warm-blooded like the other mammals we are more familiar with. In this same way we can see that some modern reptiles, like the alligator and crocodile, are related to the extinct dinosaurs.

Reptiles and dinosaurs

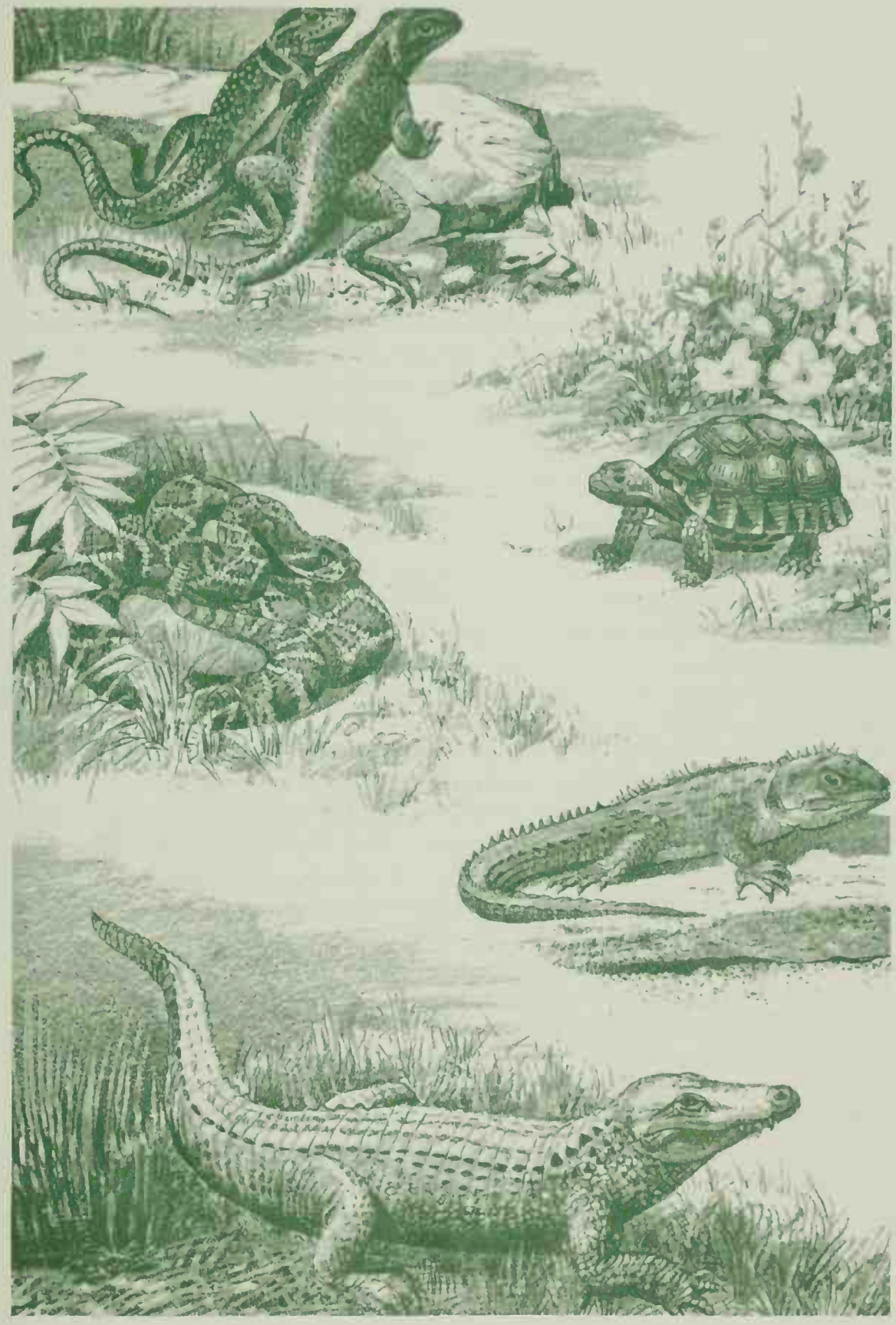
We have learned that all vertebrate animals have backbones. Let us now look more closely at the reptiles. Most reptiles, unlike amphibians or fish, are not water animals. It is true that some turtles, a few snakes, and the crocodiles and alligators do go in the water. Some of them are even good swimmers. But unlike the amphibians and fish, these reptiles have no gills. They have lungs instead, and for this reason they have to come to the surface of the water to breathe. Except for a few extinct reptiles, like the mosasaurs, ichthyosaurs and plesiosaurs, reptiles are really land animals.

Reptiles are usually scaly animals, as we have seen. They have no fur or hair, as mammals do. Also reptiles are cold-blooded, not warm-blooded like the mammals. In mammals, the body temperature is always warm and it stays about the same. It makes no difference whether it is a hot day or a cold one. But reptiles are not able to keep their body temperature the same all of the time. If it is a hot day, reptile temperatures are quite high. But if it is a cold day, their temperatures are low. When their temperatures are low, lizards and snakes and other reptiles are sluggish and inactive, so on cold days they often crawl out into the sun to warm up. Only then do they become active and move about seeking food. Mammals, on the other hand, because they are warm-blooded, may be quite active even on the coldest days.

Another difference between reptiles and mammals is in the way they have their young. Mammals, of course, are born alive. They do not hatch from eggs. And after they are born, the mother cares for the young until they are old enough to take care of themselves. But reptiles hatch from eggs. The eggs are laid in protected places or are even buried in the ground. After many days or weeks, they hatch and the young come out for their first look at the world. But there is no mother about to look after them. Only in a few kinds of reptiles does the mother ever see her own young.

We cannot of course tell whether dinosaurs were cold-blooded or warm-blooded. But there are other reasons for calling them reptiles. They had certain structures in their skeletons that are like those of modern reptiles and not like those of mammals or other vertebrates. We also know from impressions in the rocks around their skeletons that the dinosaurs had scaly skin, And finally, dinosaur eggs have been found in several places. So we know that some dinosaurs at least were egg-layers, like crocodiles and turtles, and it seems likely that all dinosaurs were egg-layers. For all these reasons, dinosaurs are classified as reptiles.

The many different kinds of extinct and living reptiles are put into different



Reptiles living today include lizards, turtles, snakes, tuataras, crocodiles, and alligators.

groups of their own according to their anatomy. Since the skeleton is all that is usually preserved of fossil reptiles, the anatomy of the skeleton is particularly important. And the skull structure is the most important of all. Scientists have found that there are five main kinds of skull structure for reptiles. As the drawings here show, there may be either one or two openings in the skull behind the eye. Or there may be no openings at all. A skull without any openings like this is called the anapsid (an-AP-sid) type. Turtles and an extinct group of reptiles – the cotylosaurs (ko-TIE-lo-sawrs) – have this kind of skull. The diapsid (die-AP-sid) type of skull has two openings behind the eye. Crocodiles, alligators and the dinosaurs are some of the reptiles that have this kind of skull. The synapsid (sin-AP-sid) skull has only one opening behind the eye. Notice here that there are only two skull bones below that opening. This kind of skull structure is found in the fin-back reptiles like Dimetrodon (die-MEET-roe-don). Another kind of skull structure is called the euryapsid (your-ee-AP-sid) type. Here there is also only one opening behind the eye, but in this case the opening is higher on the side of the skull and there are four bones below it. The fifth kind of skull structure also has a single opening in this part of the skull. But here that opening is very high near the top of the skull. Notice that there are six bones below it. This is called a parapsid (pair-AP-sid) skull. The extinct ichthyosaurs have parapsid skulls. To identify a fossil reptile, the paleontologist first looks at the skull to see what kind of structure it has. And then this skull structure tells him what kind of a reptile he has discovered.

3

Before the Dinosaurs

THE FIRST reptiles to evolve were very strange creatures that are called cotylosaurs. These were very primitive reptiles characterized by the anapsid skull structure with no openings behind the eye. The cotylosaurs lived millions of years before the dinosaurs during the Permian and Triassic periods. If you have forgotten these periods of geologic history, look back at the time scale in the first chapter. There were three different kinds of cotylosaurs during those periods, but all of them became extinct before the dinosaurs reached their peak. First, there were some cotylosaurs that looked very much like large salamanders, such as Seymouria (see-MORE-ee-ya) pictured here. There were also some small lizardlike cotylosaurs like Labidosaurus (lab-ID-o-sawr-us). And finally, there were much larger plant eaters like Diadectes (die-a-DEK-teez).

Seymouria was named after the town of Seymour in Texas, because the fossil bones of this little animal were discovered in some red shales near that town. These red shales are of Permian age and are about 225 million years old. As you can see from the picture, Seymouria was very primitive-looking and it doesn't look as though it could run very fast. We don't know what Seymouria fed on, but it may have eaten other smaller reptiles or amphibians. Or perhaps it crawled around feeding on large insects.

Labidosaurus was one of the lizardlike cotylosaurs that lived about the same time as Seymouria. One of the strange features of these animals was the drooping tip of the upper jaw. Labidosaurus was about two feet long, nearly the same length as

Above, Seymouria. *Below*, Labidosaurus.

Diadectes

Seymouria. But we get the impression that Labidosaurus was probably a more active meat eater than Seymouria was.

The plant-eating cotylosaurs were common animals during the Triassic period. One of these was the large animal that scientists call Diadectes. This animal reached a length of five or six feet and was very heavy and awkward in its structure. We know that Diadectes was a plant eater because it had blunt, peglike teeth and not the knifelike teeth of a meat eater. Related to Diadectes is a strange little reptile called Hypsognathus (hip-so-NAY-thus). This little animal reminds us of the little horned toads that are so common in Arizona and New Mexico today. Hypsognathus was not a lizard, though, and it was quite a bit larger than a horned toad, for it grew to nearly a foot in length. (In case you didn't already know, the horned toads of the southwestern United States are not really toads at all, but are lizards.)

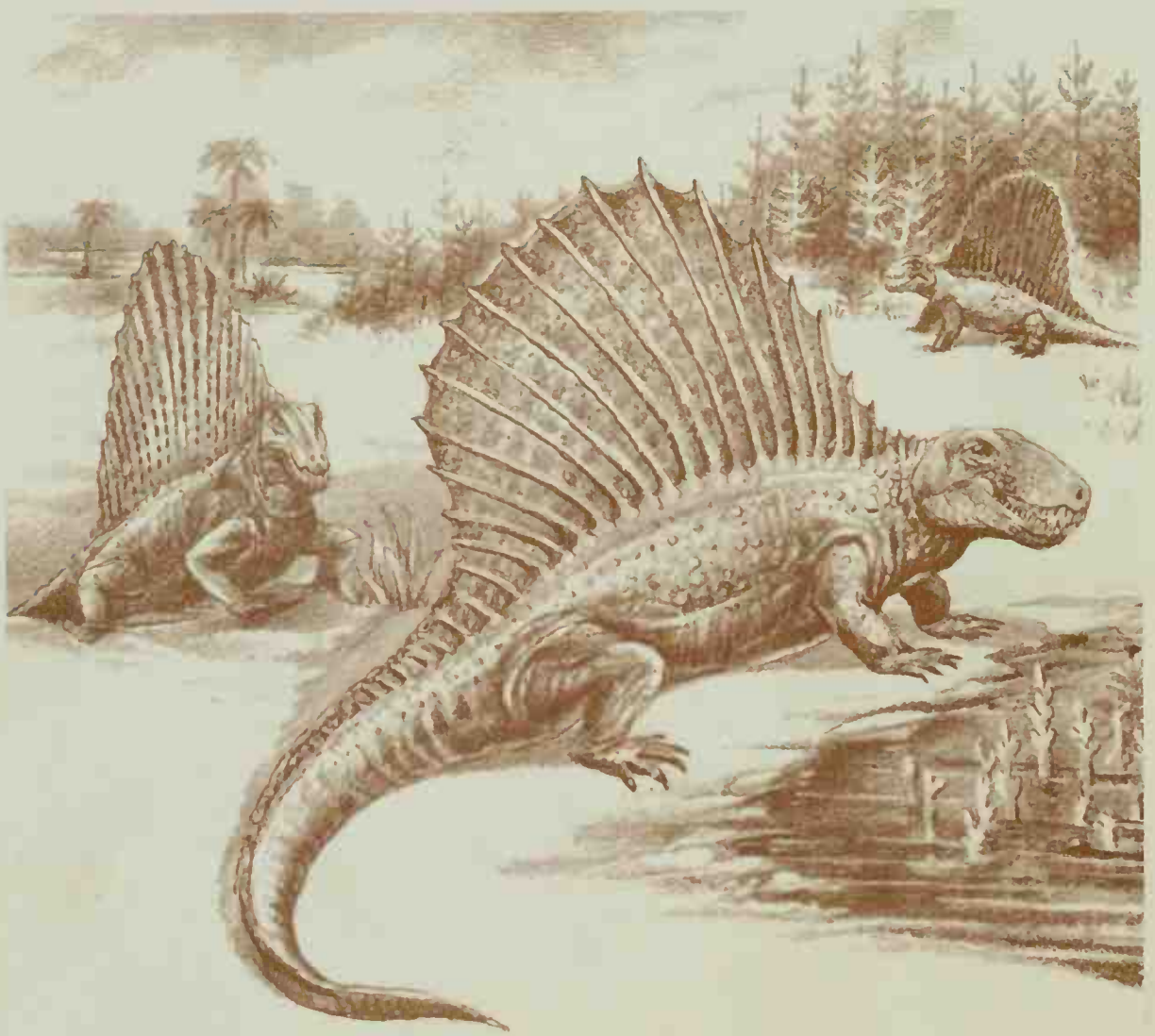
The bones of Hypsognathus were found in a rock quarry near the town of Passaic in New Jersey. Some workmen in this quarry saw the bones in a slab of red sandstone that they were chiseling out. Of course this stirred up a great deal of excitement and soon the bones were taken to the American Museum in nearby New York City to be identified.

There were many cotylosaurs like these roaming the countryside back in the days of the Permian and Triassic periods. Some of them, like those pictured here, scientists know much about. Others are not well known at all because only fragmentary parts of their skeletons have ever been found. We have much to learn about the cotylosaurs, but let us move on to some of the other early reptiles that came before the dinosaurs.

The fin-backed reptiles

Most curious of all the early reptiles are the pelycosaurs (PEL-i-ko-sawrs). Dimetrodon and Edaphosaurus (ee-DAF-o-sawr-us) are perhaps the best known of the pelycosaurs. These two reptiles are famous for the long spines that stuck up high above their backs. It is now believed that these spines were part of a great sail-like

Dimetrodon



fin. Notice that the spines of Dimetrodon were long and straight, but those of Edaphosaurus were curved and had strange crossbars that stuck out toward the sides.

Not all of the pelycosaurs had spines or fins on their backs. In fact, Dimetrodon and Edaphosaurus are the only ones that we know of with such spines. But other pelycosaurs like Ophiacodon (o-fee-AK-o-don), Sphenacodon (sfeen-AK-o-don), Varanosaurus (var-AN-o-sawr-us) and Cotylorhynchus (ko-TIE-lo-rink-us) were closely related to Dimetrodon and Edaphosaurus. Why these other pelycosaurs did not have a fin is not known, but a more important question is: Why did any of the pelycosaurs have fins? Since no one has ever seen a live Dimetrodon or Edaphosaurus, we can't be sure. At first glance, we might think this fin was like a fish fin. That might lead us to think that these two animals were swimmers. But, since both Dimetrodon and Edaphosaurus were land animals, their fins most certainly were not used like fish fins. Then what was the purpose of this strange fin? Could it have been for protection against other meat eaters? Perhaps, but probably not, for paleontologists know of no other large meat eaters living then besides the pelycosaurs. And Dimetrodon was probably the worst of the carnivores living at that time.

It has been suggested that this fin might have served as a kind of radiator. The large surface of the fin might have absorbed or released heat, thus helping these ani-

Hypsognathus

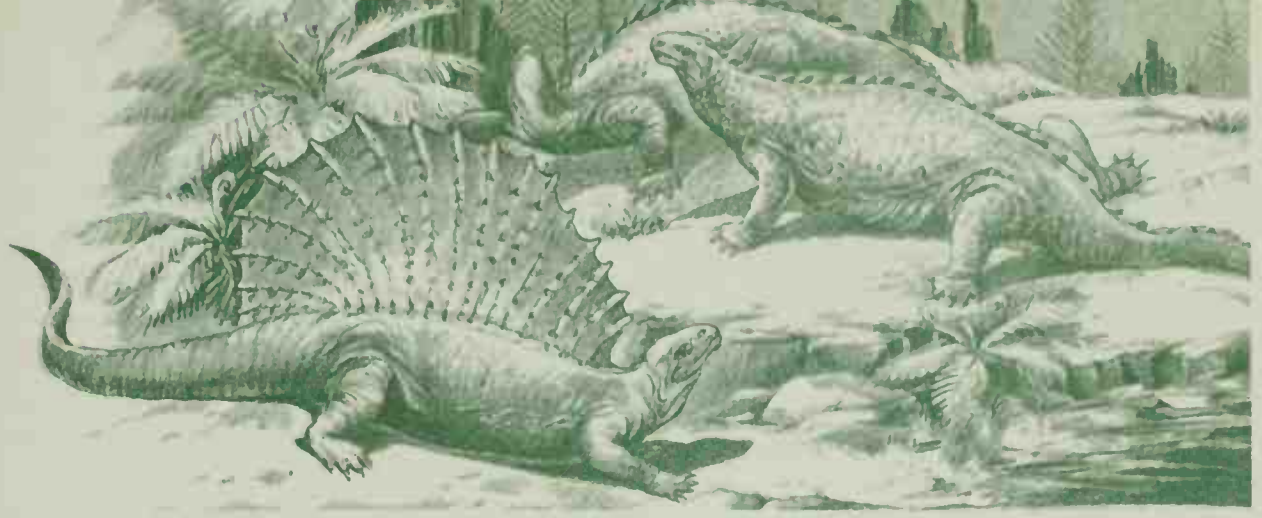
Left, Ophiacodon. *Right,* Varanosaurus.

mals to control their temperature better. For example, when Dimetrodon was cold, by moving out into the sun the fin could have absorbed the sun's heat more quickly, thus warming the animal faster than if it had no fin. Or when Dimetrodon was too warm, by moving into the shade the fin might have released the excess heat more quickly. But this is all theory. We really don't know the answer. And if we don't know what the fin was used for, we can't answer the other question of why the other pelycosaurs didn't have fins.

Dimetrodon and its near relative Sphenacodon were the meat-eating pelycosaurs. Ophiacodon and Varanosaurus both had needlelike teeth and were probably fish eaters. And Edaphosaurus and Cotylorhynchus and several other pelycosaurs that haven't been pictured here were the vegetarians. So you can see that there were all kinds of pelycosaurs living during the Permian period. They lived in many parts of the world, but most of them have been discovered in our own states of Texas and Oklahoma where there are broad areas of Permian-age rocks exposed. Although the pelycosaurs have a synapsid type of skull structure with a single opening behind the eye, scientists now believe that they evolved from some earlier anapsid reptile that looked rather like the cotylosaur Labidosaurus.

Ancient lizardlike creatures

In contrast to the large and well-known dinosaurs are a number of other curious little reptiles from the past. Some of these are grouped together and thought to be closely related to each other because of their skull structure. These animals are called



Lower left, Edaphosaurus. *Upper right,* Cotylorhynchus.

Sphenacodon

protorosaurs (PRO-tor-o-sawrs) and they all have the euryapsid type of skull. The protorosaurs were rather small creatures that also lived during the Permian and Triassic periods along with the cotylosaurs and pelycosaurs. Araeoscelis (air-ee-OSS-eel-iss) was one of the first protorosaurs. As you can see, it was very much like some of our modern lizards and it probably lived much the way some of these lizards do. But the skull of Araeoscelis is different than a lizard skull, so these animals are not classified with lizards. It seems likely that Araeoscelis lived in the shelter of shrubs and bushes or among the rocks. Its teeth suggest that it fed on much smaller reptiles or perhaps on insects. Araeoscelis never got very large, probably never growing to more than two feet in length.

A probable descendant of this earlier protorosaur is a strange reptile scientists call Tanystropheus (tan-ee-STROFE-ee-us). This animal is known only from rocks of Triassic age in Europe. Tanystropheus was only about two and a half or three feet long, but most of this length was neck. Look at the picture of this peculiar animal. Have you ever seen such a strange creature? We might imagine this animal lying close

Tanystropheus

Araeoscelis

Ornithosuchus

to the ground and occasionally stretching or whipping its long neck out to catch an insect or a small reptile. But this activity is not likely. The vertebrae or bones of the neck show us that the neck was not very flexible. It could not bend sharply, so the neck could not have moved in a snakelike fashion to catch small, quick-moving animals or insects.

The short, low body and the fairly short legs look very strange on such a long-necked animal. In fact, until a complete skeleton was found, no one believed that the long neck and the rest of the skeleton belonged to the same animal. Such a curious-looking animal makes us wonder how it lived. The short, low body suggests that Tanystropheus crouched close to the ground, probably motionless, to hide from its enemies. The short legs were not built for speed, so Tanystropheus probably could not escape by running. The teeth suggest that this animal was a plant eater. But why the long neck? Could it have been used to reach up in the shrubs for leaves or berries? Perhaps.

Scleromochlus

The dinosaur ancestors

The world certainly was a strange place back in the days of the Triassic period. There were the strange little protorosaurs and the last of the cotylosaurs. But most important to us were the ancestors of the dinosaurs – animals we now call thecodonts (THEEK-o-donts). Actually, there were several kinds of thecodonts living during the Triassic period. One of these were large crocodile-like animals called phytosaurs (FITE-o-sawrs). But we will save the phytosaurs for later because right now we are more interested in the other kinds of thecodonts – those which were the ancestors of the dinosaurs.

Several of the Triassic thecodonts are so similar to the early dinosaurs in their anatomy that scientists believe they are closely related to the dinosaurs. For example, the thecodonts had a diapsid type of skull like the dinosaurian skull. You can see from the pictures here that Ornithosuchus (or-nith-o-SOOK-us), Saltoposuchus (salt-o-po-SOOK-us) and Scleromochlus (sklair-o-MOKE-lus) were very much like some of the dinosaurs that came later. All three of these animals were very lightly built. Their bones were quite thin and hollow, almost birdlike. Their hind legs were quite long, but the front legs were rather short. This tells us that they were bipedal; that is, they ran about on their hind legs. The long tail was probably used as a counterbalance to keep the front legs up off the ground and to help balance the body. From all of these facts, we may suppose that these thecodonts were very speedy runners, taking great long strides with those long hind legs.

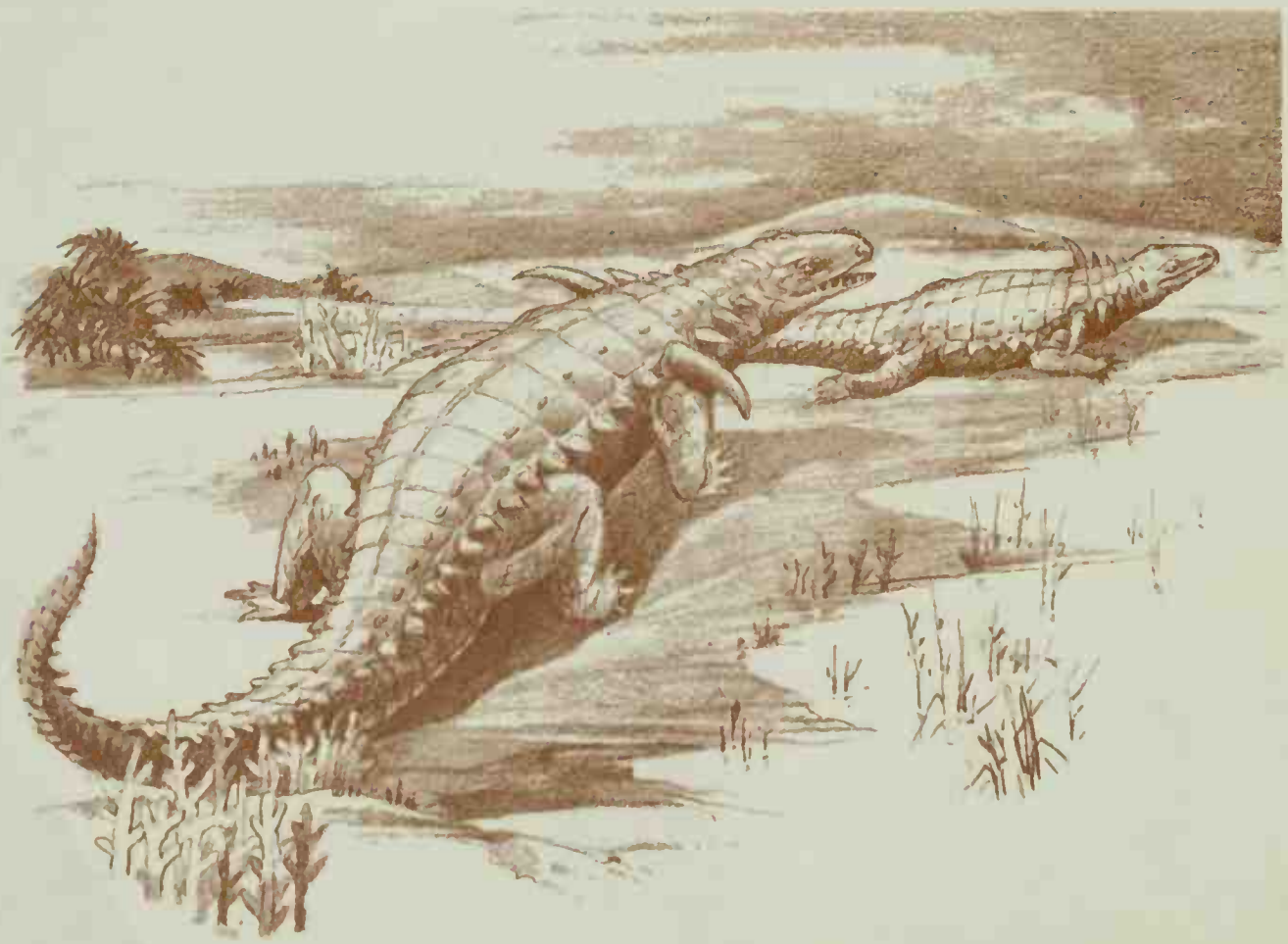
The thecodont head was always quite large and the jaws were armed with many sharp teeth. Can't you picture Scleromochlus or Ornithosuchus racing through the forest after some smaller animal, perhaps one of the protorosaurs, catching it in its front claws and gobbling it up with great tearing bites? Of course these creatures were not as large or as terrible as the meat-eating dinosaurs that came later, but still they must have been the fierce killers of their day. These thecodonts are frequently found in the Triassic rocks of Europe and Africa, and similar animals have been found in North America. So it looks as though they were quite common animals back in those days just before the dinosaurs.

Saltoposuchus

Not all of the thecodonts were built like little dinosaurs. Desmatosuchus (dez-mat-o-SOOK-us) was built more like a crocodile or like his phytosaur relatives, and it was just about the same size. Desmatosuchus was not a fast-running animal and we can be sure that it never got up on its hind legs to run after other animals. As you can see, all four legs were rather short and very nearly the same length. The short neck and the long body and tail are very much like those of a crocodile. And the sharp teeth show that Desmatosuchus also was a meat eater. Do you suppose that Desmatosuchus behaved like the modern crocodiles?

A closer look at Desmatosuchus shows us that it must have been concerned about other meat eaters attacking him. Why? Because of the rows of overlapping bony plates all along its back. Also, the sharp spikes on either side of the neck must have been for protection. Structures like these can only be for one purpose — to discourage any would-be attackers. But what meat eaters of the Triassic age were big enough to bother Desmatosuchus? Another larger thecodont? Possibly — but we really don't know. It would seem that there must have been some rather large meat-eating reptiles during the Triassic period that paleontologists have not yet discovered.

Desmatosuchus



4 The Saurischian Dinosaurs

TWO DINOSAURS named Iguanodon (ig-WAN-o-don) and Megalosaurus (MEG-a-lo-sawr-us) have the honor of being the very first dinosaurs to be discovered. Teeth and other parts of their skeletons were found in England during the early part of the 1800's. At first, the bones of Iguanodon were thought to be those of an extinct hippopotamus and the teeth were thought to be those of a rhinoceros. But finally it was realized that these fossil remains belonged to some giant plant-eating reptile. And Megalosaurus was finally recognized as a giant meat-eating reptile of the past. Soon, the remains of other kinds of extinct reptiles were discovered. Sir Richard Owen, a great natural scientist of that time, recognized that these beasts were quite unlike any of the living reptiles, and so he suggested an appropriate name for these creatures of the past. He called them the Dinosauria, meaning "terrible lizard." For a long time, this was the scientific name for all of these giant reptiles. But as more of these creatures were discovered, it was seen that there were two different kinds of dinosaurs. These two kinds were as different from each other as are the turtles and lizards of today. So two new names were put into use for these two major kinds of dinosaurs. And the scientific name Dinosauria was popularized to the word dinosaur.

Saurischian or ornithischian?

The new names that were chosen were Saurischia (sawr-ISS-kee-ya) and Ornithischia (or-nith-ISS-kee-ya). The name Saurischia means "lizard hip" or "reptile hip." Ornithischia means "bird hip." Each of the dinosaurs belongs to one or the other of

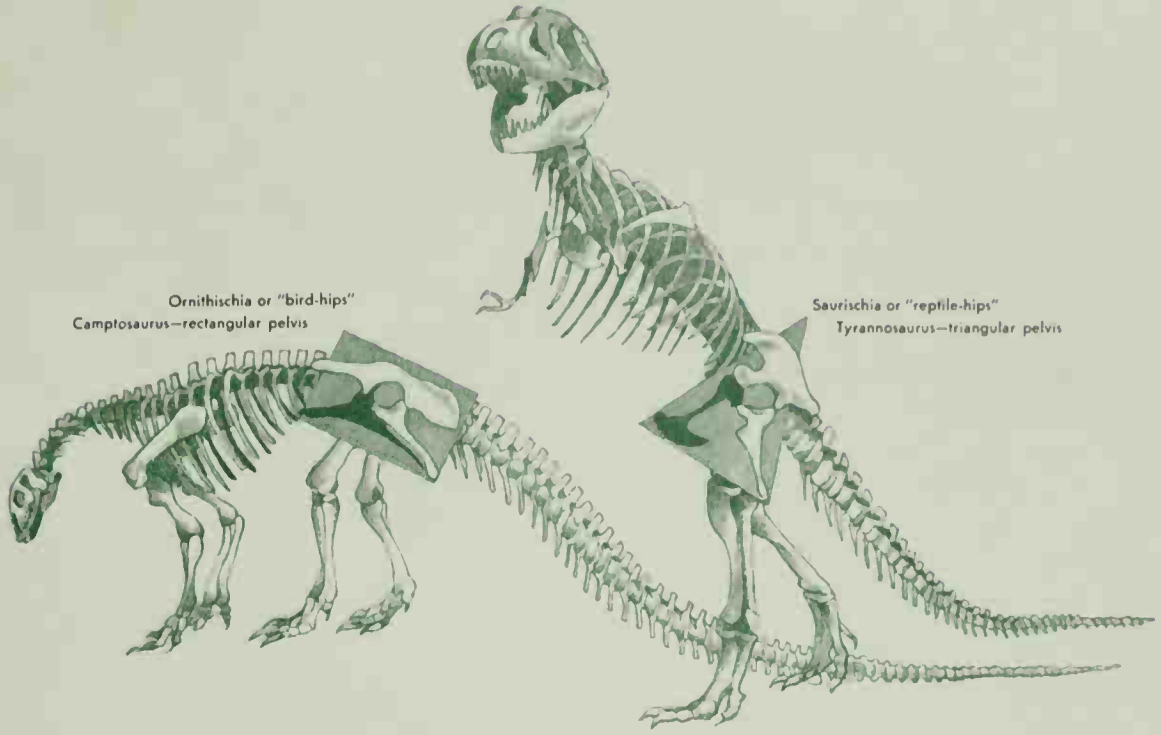
these two great families of dinosaurs. And we can decide which of these groups is the right one for any dinosaur by looking at their hip bones.

The hip, or pelvis bones, of saurischian dinosaurs is like that of the modern reptiles. The three bones that form each side of the pelvis are arranged to form a triangle with one bone at each of the three corners. The ornithischian pelvis, however, is more like that of modern birds. Here, the three hip bones are arranged in a rectangle, rather than a triangle. The front bone of the pelvis, which is called the pubic bone, reaches all the way from the front to the back of the pelvis, as does the upper bone, or ilium as it is called. The next time you visit a museum where dinosaur skeletons are on display, look at the hip bones and compare them with the drawings here to see if you can recognize the group that each belongs to.

The carnivorous saurischian dinosaurs

Perhaps the most interesting of the saurischian dinosaurs are the meat-eating or carnivorous dinosaurs. And most famous and frightening of all these is Tyrannosaurus (tie-RAN-o-sawr-us). But there were many other meat-eating dinosaurs besides Tyrannosaurus. Some of these, like Allosaurus (AL-o-sawr-us), are well known to us, but others are not. And probably some of these that are shown here will be new to you.

Coelophysis (SEE-lo-fise-iss) was one of the earliest of the meat-eating dinosaurs. Aside from the animal itself, the story of its discovery is very interesting and it shows that even after more than a century of searching, there is much yet to be discovered about dinosaurs. For a long time, all that was known about this little dinosaur was based on a few bones — some leg bones and some vertebrae from the backbone. Paleontologists had searched for a complete skeleton of Coelophysis for many years, but without success. In 1948, paleontologists from the American Museum in New York City were searching the Triassic rocks in northern New Mexico. And at a place appropriately called Ghost Ranch, they discovered some pieces of bone belonging to Coelophysis. At once the tools were brought out and a quarry was dug in the side of the hill where the bone pieces had been found. Slowly, the rock was chiseled away. At first a few bones were uncovered, and then more bones came to light. Soon a complete skeleton could be seen. The treasure, hidden for so long, had finally been found. But there were more bones, so the men kept digging — and another skeleton began to appear. And then another, and another! This was a fantastic discovery — there were dozens of skeletons all together. Some were twisted together and skeletons lay on top of other skeletons. There were full-grown animals and there were half-grown animals. And most exciting of all — there were even little baby Coelophysis skeletons. This was a wonderful reward for all that searching, for skeletons of baby dinosaurs are very very rare. So many skeletons were found in that quarry at Ghost Ranch that the museum scientists had to come back the next year. They couldn't dig all of those skeletons out during that first summer.



The two great orders of dinosaurs

What kind of an animal was Coelophysis? Actually, it was a small dinosaur, as dinosaurs go. A full-grown Coelophysis was about eight or ten feet long, but it stood only about four or five feet high and it probably weighed less than a full-grown man. It was very lightly built – an almost fragile animal. The bones were very thin and many of them were hollow. This lightweight construction means that Coelophysis must have been a very fast runner. The long hind legs prove this, too. Can you picture Coelophysis running rapidly through the underbrush, chasing the small lizardlike creatures of his day? With the long tail stretched out behind him for balance and the long neck reaching out in front, Coelophysis must have been able to catch almost any of the small animals that lived around him. The sharp, knifelike teeth tell us that Coelophysis was a meat eater. But we have better proof than this. Some of the skeletons that were found at Ghost Ranch have many small bones inside them. These bones belong to a small Coelophysis. These may be the bones of an unborn baby, for we know that a few modern reptiles hatch their eggs inside the body cavity. But these bones seem to be too big for an unborn Coelophysis. They probably are the remains of the last meal. This makes Coelophysis a terrible animal in our eyes, for it looks as though Coelophysis was a cannibal. All the evidence tells us that this animal ate its own young. While this seems a frightful thing to us, we should realize that there are other animals like this today. The crocodiles and alligators are examples of animals that often feed on their young. Certain lizards and snakes do the same, so we know that such things do happen. There seems to be no doubt that Coelophysis was a meat eater.

Podokesaurus

While Coelophysis seems like a small dinosaur to us, there were others that were still smaller. Procompsognathus (pro-komp-so-NAY-thus) and Podokesaurus (po-DOKE-ee-sawr-us) are two such tiny dinosaurs. Both lived about the same time as Coelophysis and both were meat eaters. Probably they fed on small lizardlike animals or on small amphibians. They too were very lightly built with long hind legs and tails and long flexible necks. In fact, they probably chased smaller animals just the way that Coelophysis did. And we might suppose that occasionally they used their running ability to escape from Coelophysis who probably chased them. At least we can suspect that little Podokesaurus had to worry about Coelophysis, for it lived here in North America at the same time Coelophysis did. Procompsognathus has not yet been found on this side of the Atlantic. It lived in what is now the continent of Europe, but we know that there were large meat eaters there too. And these must have chased Procompsognathus when they were hungry.

Unfortunately, we don't know much about our little Podokesaurus. Unlike Coelophysis, only one skeleton of this rooster-sized dinosaur has ever been found. And this skeleton, which was found by one of the students at Mount Holyoke College in Massachusetts, was destroyed by a fire. Fortunately someone had made a plaster cast of the skeleton before it was destroyed, so we can still see what the skeleton of Podokesaurus was like. Saltopus (SALT-o-pus) was another of these small, fast carni-

Coelophysis

vores that lived in Europe during the Triassic period. All of these animals show us that at the beginning of the age of dinosaurs there were many small, but fast, meat-eating dinosaurs in both North America and Europe. At that time, Coelophysis was the king of the meat eaters — at least on this side of the Atlantic; but there undoubtedly were similar creatures on the other continents of the world. The really big carnivores did not appear until later during the Jurassic and Cretaceous periods.

Even later, however, there were still some small carnivores. Coelurus (see-LURE-us), also known by the name Ornitholestes (or-nith-o-LESS-teez), was one of these later meat eaters that lived in North America during the Jurassic and Cretaceous times. It looked very much like Coelophysis, but it was somewhat smaller and probably never got to be as much as six feet long. But it too was bipedal and chased its meals on long hind legs. The tail was very long and flexible and must have served as a counterbalance. The neck also was long and flexible, probably for reaching out after the smaller animals that Coelurus fed on. And like Coelophysis, Coelurus was very lightly built — almost birdlike — and thus built for speed. But Coelurus was a true saurischian with the lizardlike pelvis in spite of its birdlike appearance.

Even more birdlike were two other saurischian dinosaurs that lived later during the Cretaceous period. One of these was Ornithomimus (or-nith-o-MIME-us) of North America. Another name for this dinosaur is Struthiomimus (strooth-ee-o-MIME-us). Ornithomimus means "bird imitator" and Struthiomimus means "ostrich imitator."

Both of these names are very appropriate, don't you think? A very similar dinosaur lived about the same time in Asia. This Asian relative of Ornithomimus is called Oviraptor (o-vee-RAP-tor), which means "egg stealer." Ornithomimus was about the same size as an ostrich, but Oviraptor was much smaller, more nearly the size of a large turkey. Both of these birdlike creatures are related to those earlier meat eaters that we have seen, but in one way they are quite different. Neither Ornithomimus or Oviraptor had those sharp teeth that we saw in Coelophysis. In fact, they had no teeth at all. Instead they had a beaklike jaw – again they are similar to the birds. What kind of food could these strange reptiles have eaten? They certainly did not eat meat without teeth. And it certainly doesn't seem likely that they ate leaves or grass without teeth to grind it up. Some paleontologists think they might have fed on the eggs of other dinosaurs. Some of those eggs were quite large and could have provided a good-sized meal for Oviraptor. As you may have guessed, this is where Oviraptor got its name – especially since the bones of this animal were found together with a nest of Protoceratops (pro-toe-SAIR-a-tops) eggs. Food of this sort seems quite right, for we can easily imagine Ornithomimus or Oviraptor sneaking up to a nest of eggs. Quickly he breaks a hole in the shell of an egg with his pointed beak. Then he sucks out the insides. Suddenly, he hears something nearby and away he races on those long hind legs with the whiplike tail waving behind him.

Of course we can't be sure that Ornithomimus or Oviraptor ate eggs. They may have led a rather quiet and uninteresting life feeding on soft fruits. Those forelegs and

Left, Protoceratops. *Center and right,* Oviraptor.

claws may have been used for pulling branches down and picking the fruit or berries. Or they might have fed on insects. We really don't know what their meals may have been, but as we noted before, it is of special interest that skeletons of Oviraptor have been found with the nests of Protoceratops eggs.

One of the most interesting of all dinosaurs is the very tiny animal known to science as Compsognathus (komp-so-NAY-thus). This little dinosaur was only about as big as an ordinary-sized chicken. What a contrast with the huge brontosaurs that lived at the same time during the Jurassic period! The beautifully preserved and complete skeleton of Compsognathus was found in a slab of limestone in Germany. It was very much like its somewhat larger ancestors, such as Procompsognathus. And although smaller, it too probably was very active and chased many smaller lizardlike reptiles and mouselike mammals for its meals.

Top, Saltopus. *Bottom,* Procompsognothus.

Coelurus (or Ornitholestes)

Have you noticed that all of these smaller meat-eating dinosaurs are very bird-like and are built for great speed? Did you notice their long hind legs built for running? Speed, of course, is very necessary in an animal that feeds on other animals, for before it can eat, it must catch its meal – which is running as hard as it can to escape. But not all of the meat-eating dinosaurs were such fast runners. As you will see, many of the carnivores grew to huge sizes. Instead of speed, they depended on their great size and fearsome teeth and claws to overpower and kill their victims.

Such were Ceratosaurus (sair-AT-o-sawr-us), Megalosaurus and Allosaurus of the Jurassic period. And during the Cretaceous period there were such giants as Acrocanthosaurus (ak-roe-KANTH-o-sawr-us), Gorgosaurus (GORE-go-sawr-us) and of course Tyrannosaurus. Like Coelophysis and the other meat-eating dinosaurs, these larger forms were bipedal. They walked about on long, strong hind legs and they all had long tails for balancing. But none of these large meat eaters were very birdlike. Instead, they were all very heavy. Their bones were large and heavy, not hollow and thin as in Coelophysis. All of these features point to the fact that they were animals of great strength, but certainly were not very fast runners. This suggests that they probably fed on larger, slow-moving, plant-eating dinosaurs. Perhaps they fed on dinosaurs like the duck-billed or horned dinosaurs, or perhaps on some of the armored dinosaurs.

The first, and one of the best known of these terrible meat eaters, was Allosaurus. This animal is also known to scientists by the name Antrodemus (an-troe-DEE-mus).

Ornithomimus (or Struthiomimus)

Left, Allosaurus (or Antrodemus). *Right,* Ceratosaurus.

Antrodemus roamed about North America during the Jurassic period, the same time as did Brontosaurus (BRON-toe-sawr-us). Bones of this animal — or an animal very much like it — have also been found in Africa and in Asia. So it looks as though animals all over the world had to keep a good watch out for Antrodemus. One remarkable discovery here in North America was of Antrodemus bones and teeth together with bones of Brontosaurus. The bones of Brontosaurus had tooth marks on them — tooth marks that fit the jaws and teeth of Antrodemus. Here is unusual proof of the food of Antrodemus. What battles there must have been in those days! The sight of Antrodemus attacking and killing a huge Brontosaurus would have been a terrifying experience. Do you still wish for our imaginary time machine to journey back to the age of the dinosaurs?

A few years ago, an amazing discovery was made in Utah, a discovery almost as good as that of Coelophysis. Thousands of bones were uncovered there in a Jurassic sandstone. Most of the bones belonged to Antrodemus, but there were a few other dinosaurs, too. And like those skeletons of Coelophysis, there were some bones of young Antrodemus. Some of the babies were only about fifteen feet long. But the biggest surprise of all was the finding of Antrodemus bones that were almost as large as those of Tyrannosaurus. This discovery has shown us that Antrodemus grew to more than forty or forty-five feet in length and stood nearly eighteen feet high. Before this discovery was made, scientists thought that Antrodemus never grew to be more than about thirty-five feet long.

Another large meat eater that lived at the same time was Ceratosaurus. This monster looked very much like Antrodemus and was almost as large. But it had a

Compsognathus

strange bump or horn on top of its nose. No one really knows what this horn may have been used for. Ceratosaurus was so much like Antrodemus in every other way, though, that some paleontologists think they were one and the same animal. It may be that those with the nose horn were the males and those like Antrodemus without any horn were the females. But of course this is a mystery that we cannot solve right now.

Megalosaurus, you remember, was one of the first dinosaurs to be found. This twenty-foot-long beast roamed about Europe, Africa and Asia during the Jurassic and Cretaceous periods. Although not as large as Antrodemus and the later Tyrannosaurus of North America, those sharp, knifelike teeth tell us it was an animal to keep away from.

By Cretaceous times, many of these carnivores had become extinct, but in their places lived even more terrible dinosaurs. Gorgosaurus was one of these Cretaceous carnivores. This meat eater reached a length of nearly thirty-five feet and had a mouth full of long, daggerlike teeth. The hind legs were long and powerful for running and fighting, but the front legs were very short with small clawed "hands." So short were the front legs that they could just barely touch each other. But who needs long front legs and claws with a mouth like that of Gorgosaurus? Living about the same time was another giant carnivore — Acrocanthosaurus. Only a few skeletons of this animal have been found so far and they were discovered about fifteen years ago in a sandstone quarry in the state of Oklahoma.

Acrocanthosaurus

Most famous of all the dinosaurs is Tyrannosaurus, of course. And it is no wonder. A flesh-eating monster the size of this animal is not easily forgotten. Even though it has long been extinct, the name Tyrannosaurus brings a vivid picture to everyone's mind. And this name is very proper — it means "tyrant lizard." Tyrannosaurus stood almost as tall as a two-story house and was more than fifty feet from the tip of its terrible jaws to the end of its tail. The head alone was enormous — almost five feet long. From our point of view, this head looks as though it were all mouth. And it was a frightening mouth nearly four feet long and armed with dozens of great daggerlike teeth, some as much as six inches long. It is no wonder that most of the other dinosaurs that lived during the reign of Tyrannosaurus were protected by long horns, spikes and bony armor.

Tyrannosaurus is closely related to Gorgosaurus and Antrodemus, two of the carnivores that lived in North America earlier. Looking at the pictures of these three animals, you can see how much alike they were. But notice the strange front legs of Tyrannosaurus. They were extremely short, so short that they could not touch each other. Only two claws are left in the front feet. We cannot help wondering what good such ridiculous "arms and hands" were to Tyrannosaurus. They were not long

Gorgosaurus attacking Ornithomimus

Megalosaurus

enough to reach the mouth, so they were of no use in feeding. And they certainly were of no use in walking or in fighting. It seems to us that Tyrannosaurus lost all need of front legs and claws. Moving through the forests on those powerful hind legs, the tremendous jaws and teeth were all the fighting equipment needed.

In spite of the fact that Tyrannosaurus is probably the most famous of all dinosaurs, only a few skulls and skeletons of this huge beast are known. Most of these are not complete either. The nearly perfect skull and skeleton on display in the American Museum has given us nearly all of our knowledge of this giant. Perhaps someday more skeletons of Tyrannosaurus will be discovered in Montana where the existing skeletons were found nearly forty years ago.

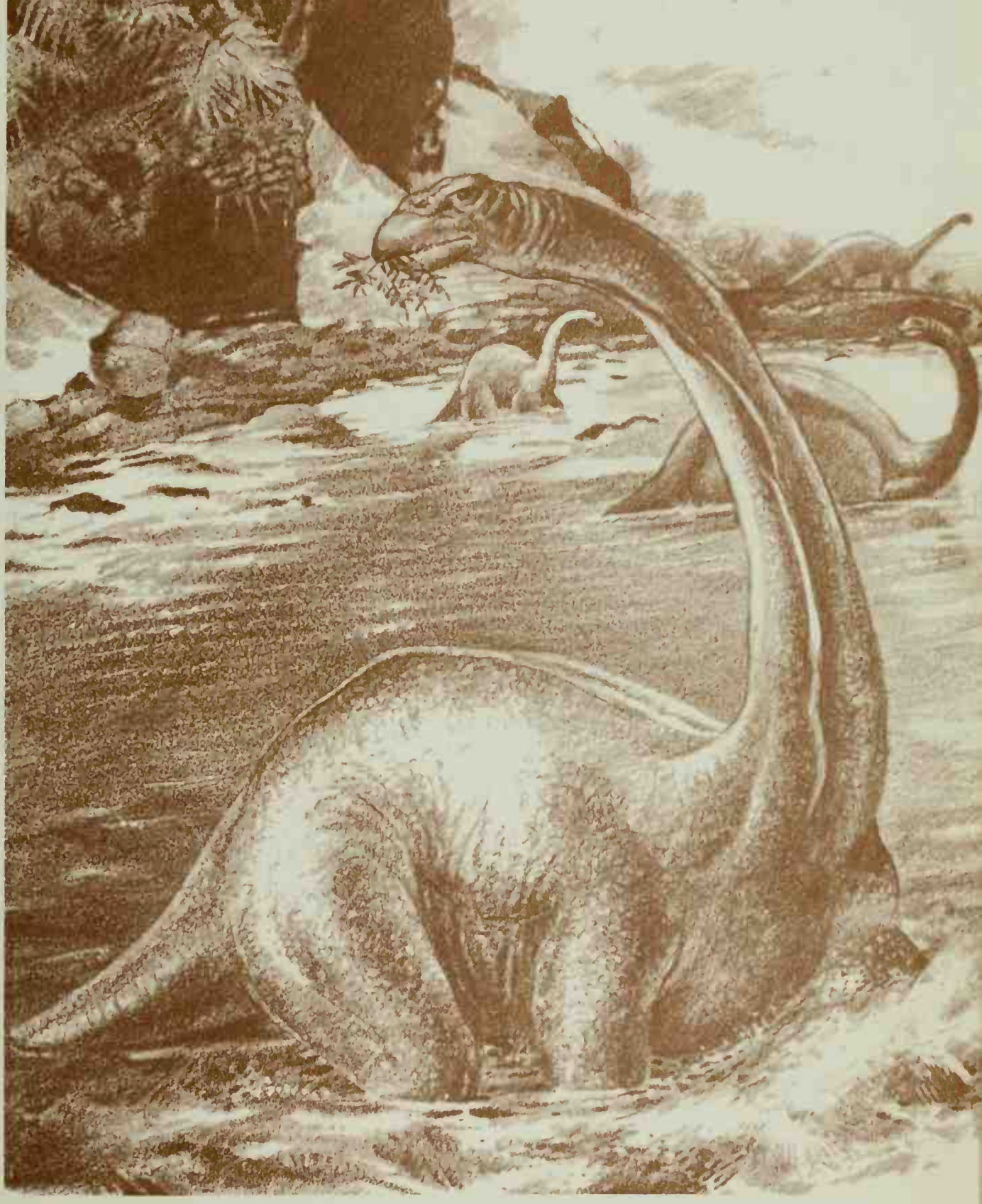
Tyrannosaurus

The thunder lizards

Not all saurischian dinosaurs were two-legged flesh eaters. Living and evolving at the same time was another group of lizard-hipped or saurischian reptiles. These were the sauropods like Brontosaurus and its relatives. The name Brontosaurus means "thunder lizard" and this description could well be applied to the other great sauropods like Diplodocus (di-PLOD-oke-us) and Brachiosaurus (BRAK-ee-o-sawr-us). There were many different kinds of giant sauropods like these that roamed over nearly all of the continents of the world during the Jurassic and Cretaceous periods. These were the giants of all time as far as land animals are concerned. Only some whales exceed the sauropods in total size. Let us look as these huge plant eaters in the order in which they appeared during the age of the dinosaurs.

We saw some of the Triassic forerunners of the great carnivores earlier. If we look back at the Triassic period again, we will see some of the other dinosaurs that we missed before. These are sometimes called the prosauropods (pro-SAWR-o-pods), because they are thought to be the ancestors of the great sauropods like Brontosaurus. The best known of these Triassic ancestors is a reptile called Plateosaurus (PLATE-ee-o-sawr-us). At first glance, it looks a little bit like Brontosaurus, but it is much smaller. We also notice that its front legs were quite a bit shorter than its hind legs. At times, Plateosaurus must have walked around on its hind legs with its front legs up in the air. Brontosaurus could never have moved about in this way. But Plateosaurus was not a true sauropod; it was more primitive, and in its peculiar bipedal structure it was more like its thecodont ancestors Ornithosuchus and Saltoposuchus.

Brachiosaurus



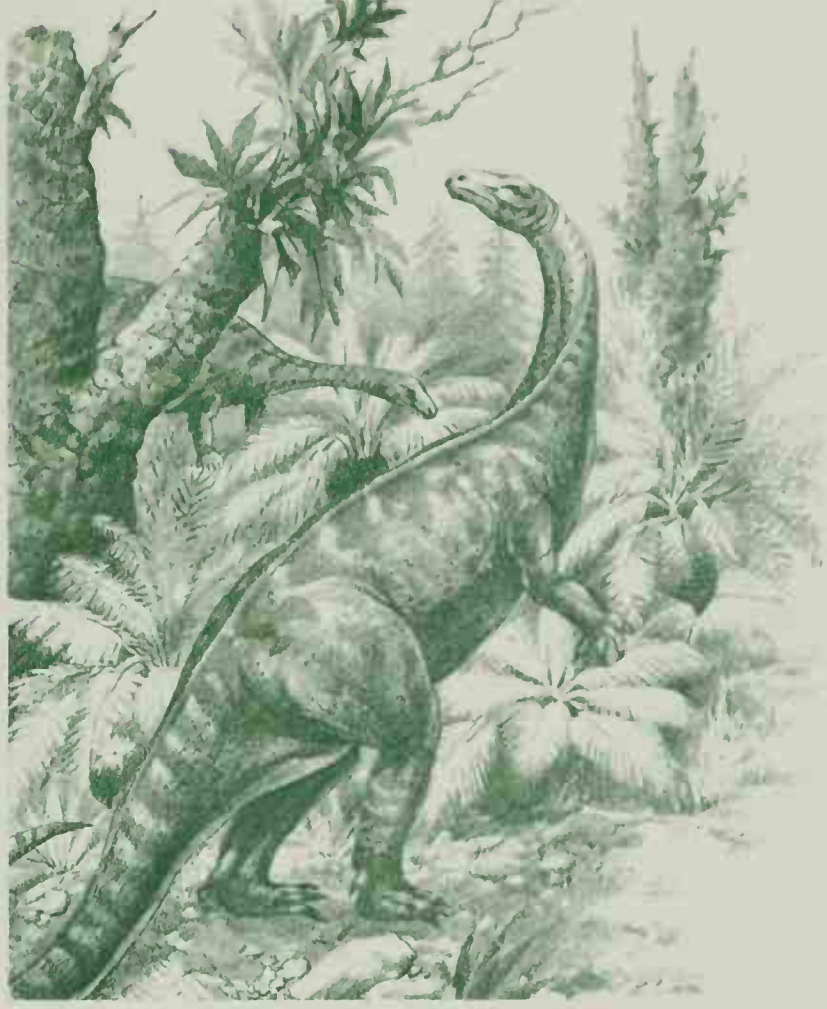
Brontosaurus (or Apatosaurus)

Diplodocus

Plateosaurus was only about twenty feet long, but it was quite heavy in its build and was not at all flat as its name suggests. The head was rather small, like that of the later sauropods and unlike most of the carnivores. In the mouth were small, blunt, peglike teeth. Such teeth would be of no help in cutting or tearing flesh, so we suspect that Plateosaurus was a plant eater. Plateosaurus has been found only in Europe, but a smaller relative is known from Triassic rocks of North America. This animal is called Yaleosaurus (YALE-ee-o-sawr-us) in honor of Yale University, which has the fine skeleton of this small dinosaur. Yaleosaurus was only about ten or twelve feet long, but it looked a great deal like its European cousin. The hind legs again were the longest and the front legs were quite short. And in the mouth we find the same kind of blunt teeth that we saw in Plateosaurus.

By the beginning of the Jurassic period, we see no more of the prosauropods like Plateosaurus and Yaleosaurus. Instead, we find their larger descendants — Brontosaurus, or more correctly Apatosaurus (a-PAT-o-sawr-us). We also see the longest of

Plateosaurus



all land animals — Diplodocus — and two other giants, Camarasaurus (KAM-are-a-sawr-us) and Brachiosaurus. If we look in Europe and Africa we will also find some of these sauropods like Brachiosaurus and Camarasaurus. Then later during the Cretaceous period, still other giants like Cetiosaurus (SEET-ee-o-sawr-us) and Titanosaurus (tie-TAN-o-sawr-us) roamed through European and Asian swamps.

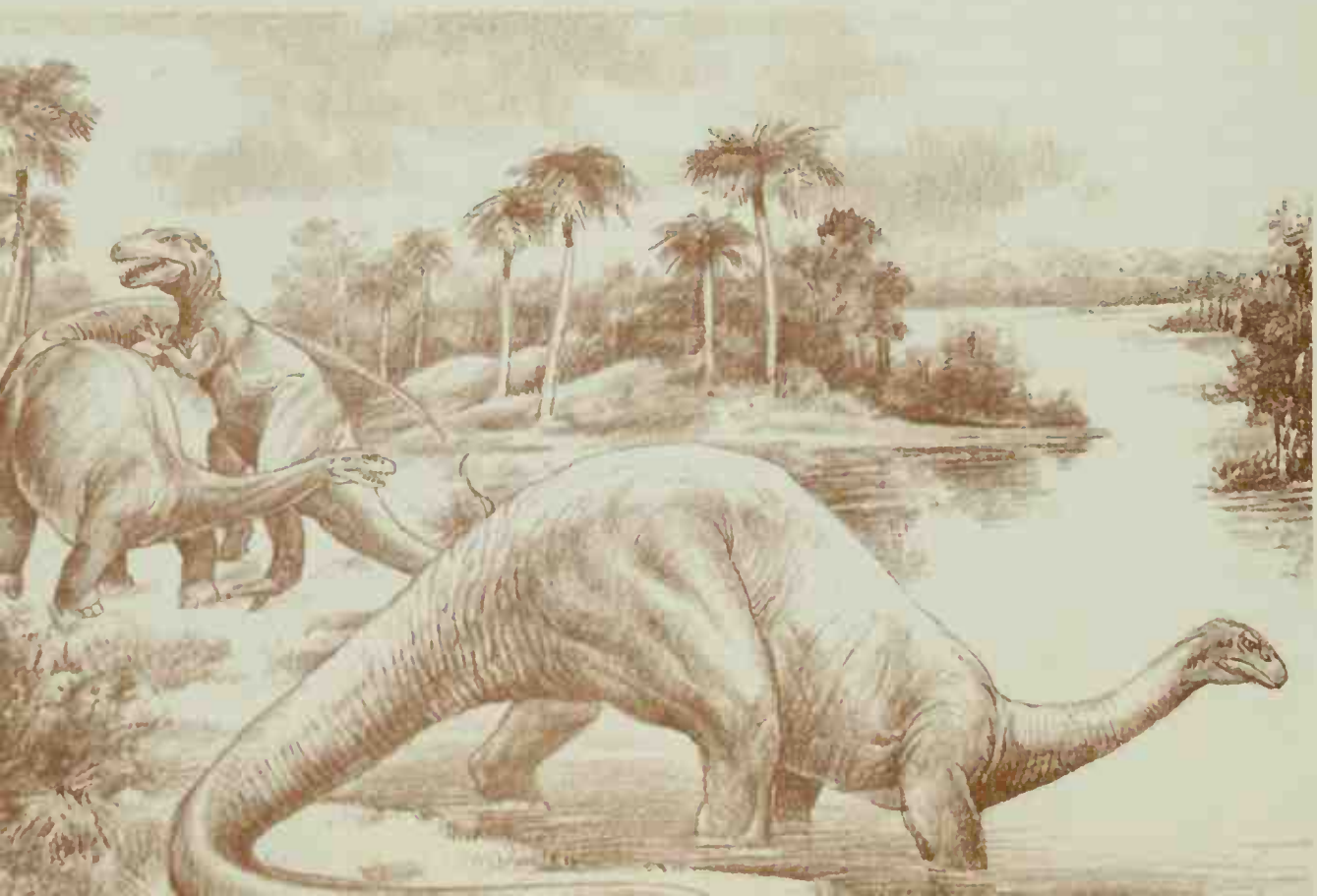
Apatosaurus, or Brontosaurus, is known to everyone, but the other kinds of sauropods were probably just as common. They were all giants reaching lengths of sixty, seventy, eighty feet and more. And some, like Brachiosaurus, had real weight problems, since they must have weighed at least forty or fifty tons! Brontosaurus and Diplodocus were actually lightweights alongside of Brachiosaurus, for they probably didn't weigh more than twenty tons. Why did the sauropods get so big? This is a question that we would all like to have answered. It seems impossible that any land animal could have grown so large. Yet, here are the bones and skeletons. They are not imaginary — they are very real. And Apatosaurus and all his relatives were just as real 150 million years ago. Even the elephants of today seem small alongside Brachiosaurus or Diplodocus. Just think, Brachiosaurus weighed as much as ten elephants and could easily have raised his head up and looked in a fourth-floor window!

If all animals are small, there does not seem to be any reason for an animal to be big. But let us think about that for a moment. In every kind of animal, most are about the same size. But there are always a few that are quite a bit bigger than the rest, just as there are a few that are smaller. During the life of every animal, there are times when it must compete or fight with others of its kind. At those times, the larger animal usually wins. Then we see that there is some value in being bigger than the others of your kind. This is particularly true if there are natural enemies about, such as Gorgosaurus or Antrodemus. For it is clear that the larger animals may be better able to fight off their enemies. Thus some animals that were too large to hide from their enemies may have grown even larger in order to protect themselves from other animals.

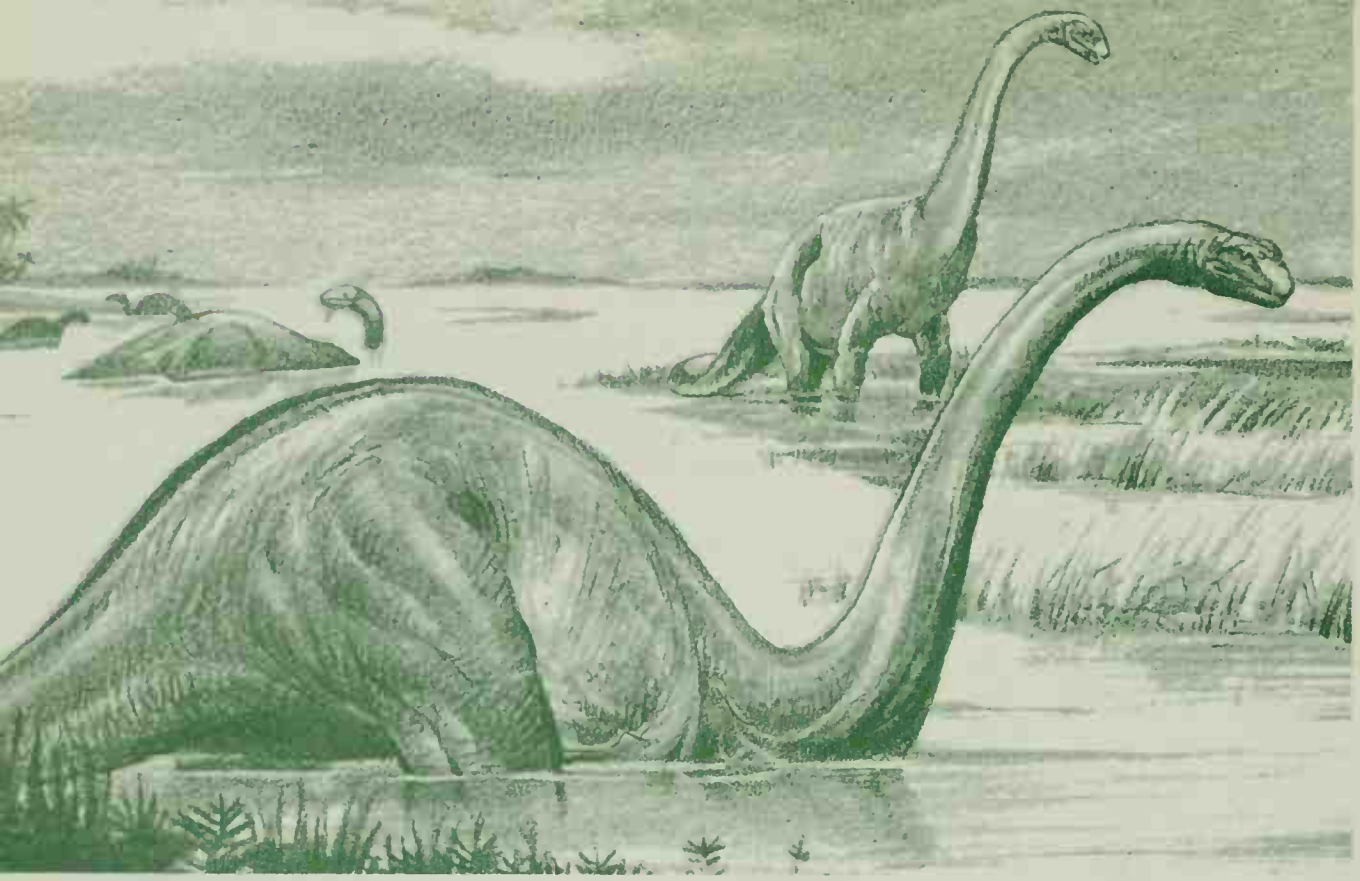
But being big, like the elephants or the sauropods, has its bad effects too. The larger an animal is, the more food it needs. The giant sauropods must have required great quantities of food. In fact, with that small mouth, they must have spent almost all of their time eating. We can suppose that during the time of the sauropods there must have been plenty of plant food about. If food had been scarce, it would have been very hard to be a giant with a big appetite.

There are other problems that go along with being a giant, too. Bone is usually quite strong, but of course it will break sometimes. The great size and weight of the sauropods would have required great strength in the leg bones and backbone. Some paleontologists have said that animals like Brachiosaurus and Apatosaurus could not

Titanosaurus



Yaleosaurus



Cetiosaurus

have walked about on dry land because their bones were not strong enough to support all that weight. It is believed that these great dinosaurs lived in swamps and lakes where the water buoyed up their bodies. In this case, the legs would not have to carry all that weight because the animal would have been half floating.

But there is good evidence that suggests that the sauropods did not spend all of their time in the swamps. Tracks of a big brontosaur-like animal have been found in a sandstone in central Texas. Most of the tracks show no mark made by the tail. It is not likely that the long, heavy tail of the sauropods was carried up off the ground. The tail was probably dragged along behind. So these tracks without any tail mark show that the tracks were made while the animal was wading through water and the tail floated along behind instead of being dragged along the bottom. But one set of tracks did show a tail mark. In this case, the water was too shallow to float the tail off the bottom. And, of course, if the water was too shallow to float the tail, it was not deep enough to float the body of that giant sauropod. Here we see clear proof that some of the brontosaur-like animals could walk about out of water.

Camarasaurus

Even though we know now that some of the large plant eaters could walk about in very shallow water or on dry land, scientists agree that these animals probably spent most of their time in swamps or lakes. Any other kind of life seems too hard for such large and heavy animals. There are other reasons for believing this, in addition to the tracks without tail marks. Most of these sauropods, like Diplodocus, had their nostrils located in a peculiar place. Instead of being at the tip of their snout, as they are in most animals, they were located near the top of the head, above the eyes. In Brachiosaurus, the nostrils were at the top of a large hump on top of the head — almost like craters in a volcano. This arrangement is like that seen in modern whales and porpoises and in some of the extinct aquatic animals like the phytosaurs. With the nostrils located high on the head, the animal could stretch its neck up so that just the top of the head came above the surface of the water. In this way it could breathe without exposing much of the head above water.

The giant sauropods were strange beasts indeed; beasts that we find very difficult to imagine, but animals that we all would like to see — at a distance.

Iguanodon

5 The Ornithischian Dinosaurs

We learned earlier that there were two major kinds of dinosaurs, the saurischians or "lizard-hipped" reptiles and the ornithischians or "bird-hipped" reptiles. So far we have read only about the saurischian dinosaurs. All the carnivorous dinosaurs and all the brontosaur-like dinosaurs are called the saurischian dinosaurs. The rest of the dinosaurs, all of which were plant-eating animals, had the birdlike pelvis and are called the ornithischian dinosaurs, even though most of them don't look at all like birds. The ornithischians include the duck-billed dinosaurs and their relatives, the armored dinosaurs, the stegosaur-like dinosaurs, and the horned dinosaurs. All of these have the diapsid type of skull, like the saurischian dinosaurs, and all of them were plant eaters. Until recently no ornithischian dinosaurs were known from Triassic rocks, but they were thought to have evolved from early Triassic thecodont ancestors, like the saurischian dinosaurs. A new discovery in South Africa of a small ornithischian dinosaur has proven that there were Triassic ornithischians after all. Future exploration in this part of the world should some day show us whether or not these "bird-hipped" dinosaurs really did evolve from thecodonts.

During the Jurassic and Cretaceous periods, there were a great many bipedal ornithischians. Because of their two-legged pose and the three-toed structure of their feet, they have been classified together as the Ornithopoda (or-ni-THOP-ode-a), which means "bird foot." One of the first and most primitive of the ornithopods was a medium-sized animal about fourteen feet long called Camptosaurus (KAMP-toe-sawr-us). Its name means "bent lizard" and the reason for this name is easily seen.

Thescelosaurus

The front legs were well developed, but they were much shorter than the hind legs. It is almost certain that Camptosaurus could walk about on its hind legs. But the bones of the front legs look as though they were used for walking too, in spite of their short length. So Camptosaurus may have gotten down on all four feet at times. In this position, it does indeed look like a bent lizard, all hunched over. Camptosaurus bones have been found both in North America and in Europe, but most of the skeletons came from an area called Como Bluff in Wyoming. Bones of Apatosaurus, Stegosaurus (STEG-o-sawr-us) and Antrodemus were also found there in what might be called a great dinosaur graveyard. These bones show us that all of these dinosaurs lived together back during the days of the Jurassic period.

We wonder how Camptosaurus escaped from the large meat-eating creatures like Antrodemus. We can see from the pictures that it was not built for great speed. And it had no horns or armor. The teeth were blunt, leaflike structures, so it was certainly a plant eater and did not fight by biting. How did Camptosaurus avoid

Camptosaurus

the flesh eaters that lived during his time? Most likely, it didn't every time. But we may guess that Camptosaurus was a rather quiet, shy animal and it probably hid from its enemies.

Iguanodon, you will remember, is a rather important dinosaur. It was a few teeth and bones of this animal that first told us, over a hundred years ago, that there had once been such things as dinosaurs. Iguanodon was very much like Camptosaurus, except that it was larger. It too had longer hind legs than front legs. And scientists think that Iguanodon also moved about either on all four legs or on just its hind legs alone. It was a plant eater like Camptosaurus, but Iguanodon at least had some equipment for fighting back against its enemies. The front legs were quite strong and on each "hand" there was a large, sharp spike. These large European dinosaurs were probably able to inflict a serious wound in any animal that had the courage to attack them.

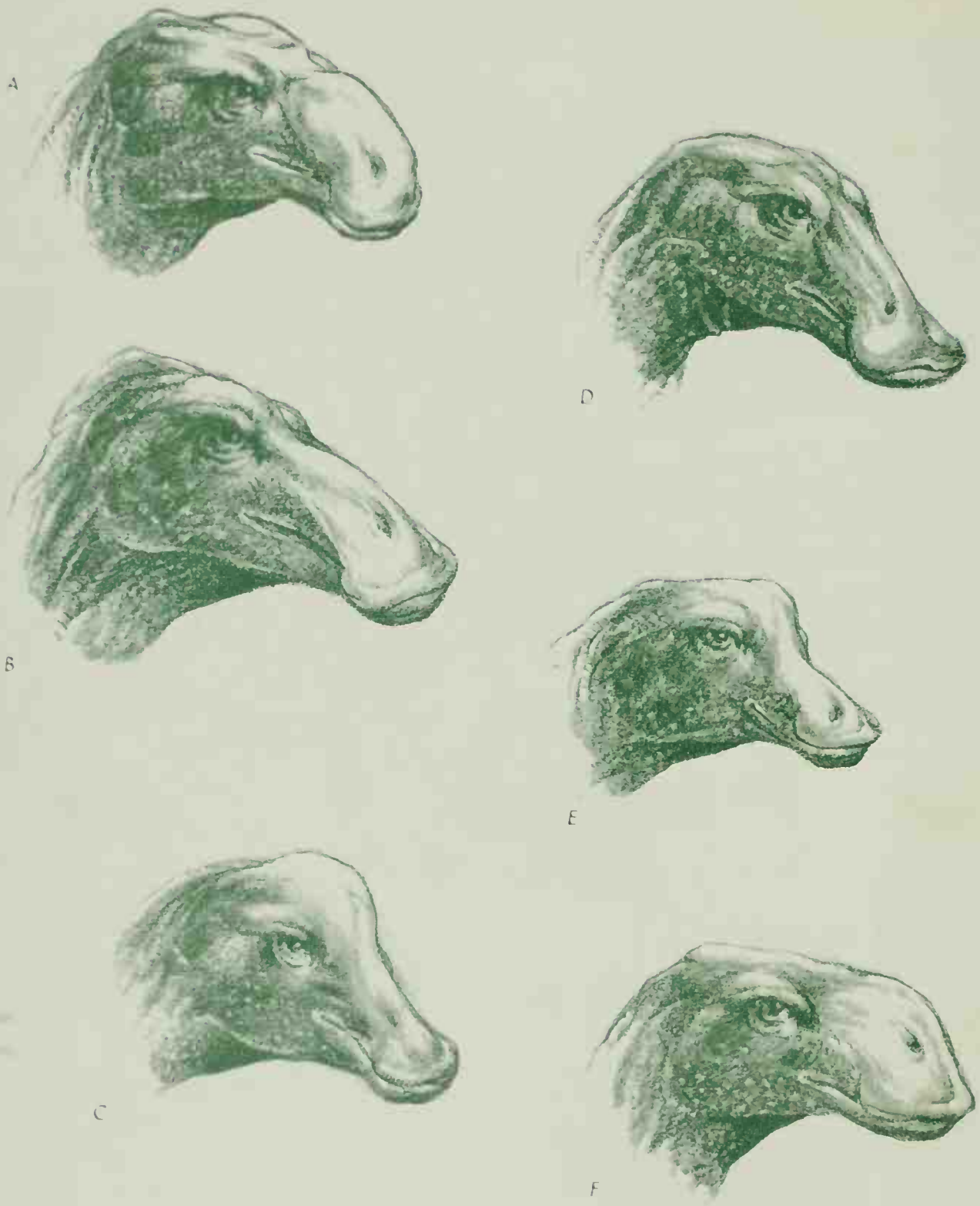
Camptosaurus and Iguanodon both lived toward the end of the Jurassic period and at the beginning of the Cretaceous period. A close relative of theirs that lived somewhat later in the Cretaceous period was an animal called Thescelosaurus

Edmontosaurus

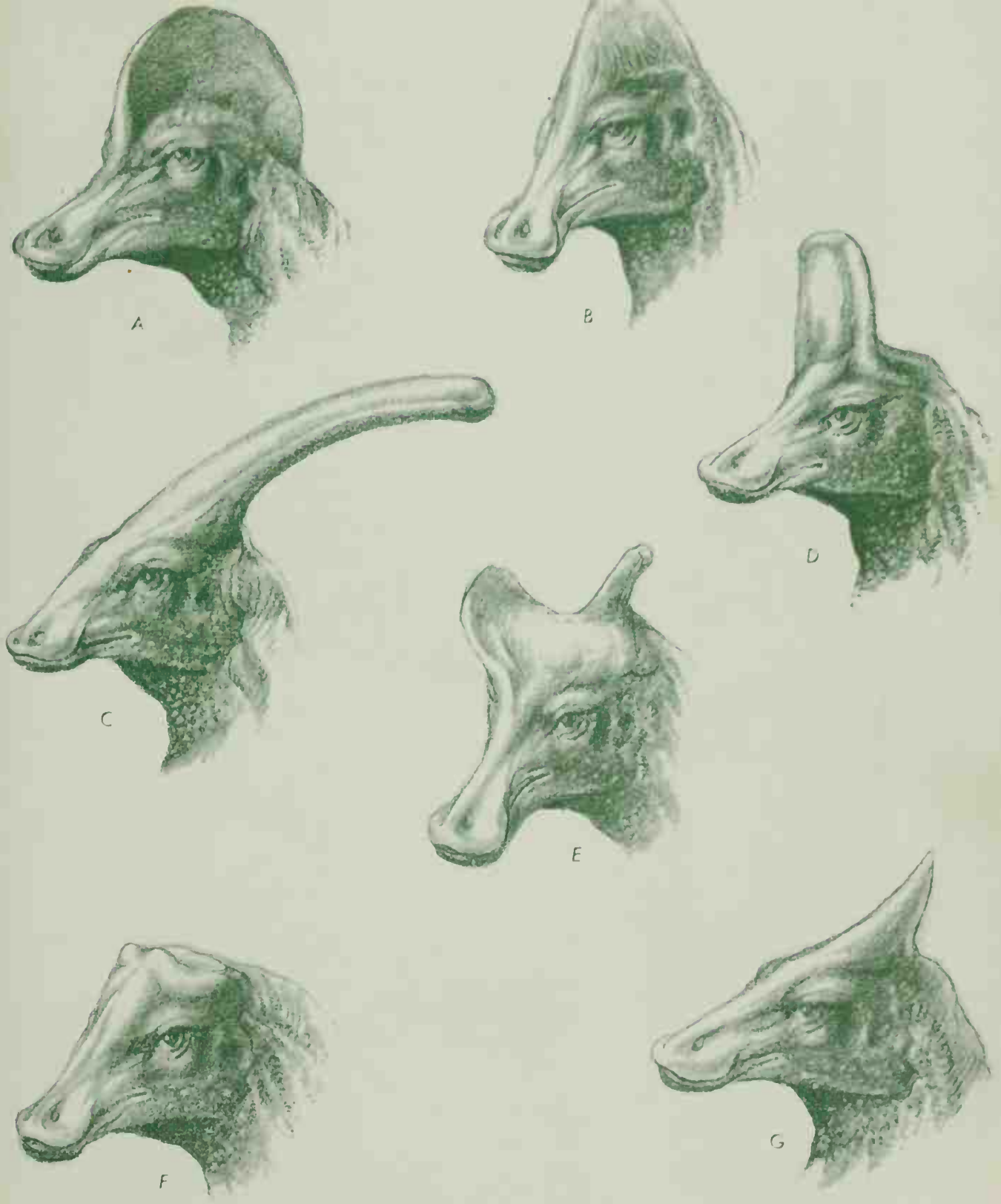
(THESS-el-o-sawr-us), of western Canada. Very few bones of this dinosaur have been found, but the skeletons that have been discovered show that it too probably was bipedal like Camptosaurus. Thescelosaurus may be one of the last descendants of Camptosaurus.

A curious little dinosaur that has been found only in southern England is pictured here under the name Hypsilophodon (hip-si-LOFE-o-don). This name was chosen because the teeth of this little animal have high crests or ridges on them, and thus the name means "high-crested tooth." Hypsilophodon is much more primitive in its skeletal structure than we would expect in an animal from the Cretaceous period. If it had been found in rocks of Triassic age we might think it was an ancestor of the other ornithopods, but coming from Cretaceous rocks, it is much too late in time to be an ancestor of Camptosaurus or Iguanodon. This little animal was no more than five or six feet long. The "hands" and feet were built a little differently than

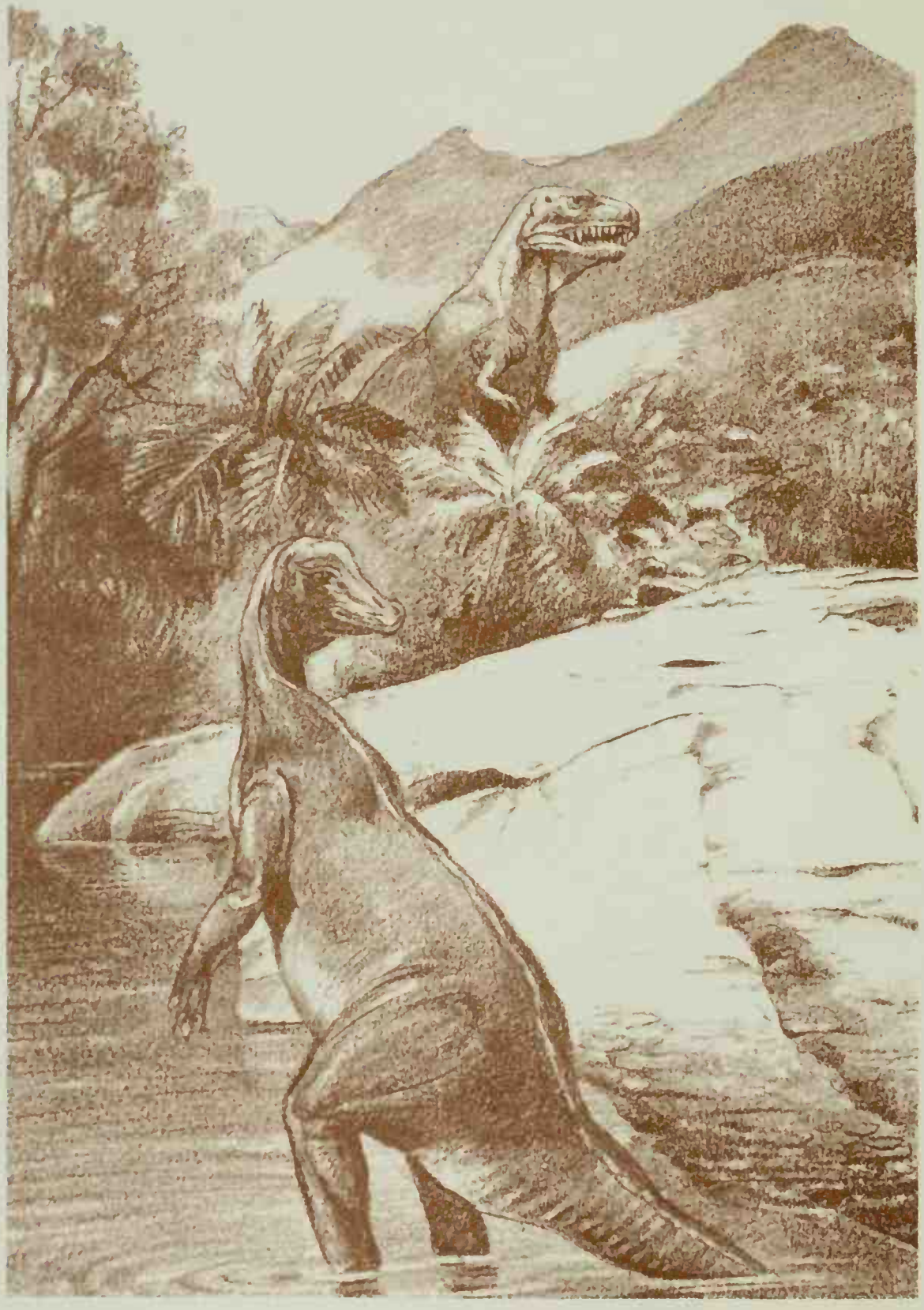
Hypsilophodon



FLAT-HEADED DUCKBILLS: *A* — Kritosaurus. *B* — Edmontosaurus. *C* — Chenesaurus. *D* — Anatosaurus. *E* — Procheneosaurus. *F* — Brachylophosaurus.



CRESTED DUCKBILLS: *A* — Corythosaurus. *B* — Hypacrosaurus. *C* — Parasaurolophus. *D* — Tsintaosaurus. *E* — Lambeosaurus. *F* — Prosaurolophus. *G* — Saurolophus.

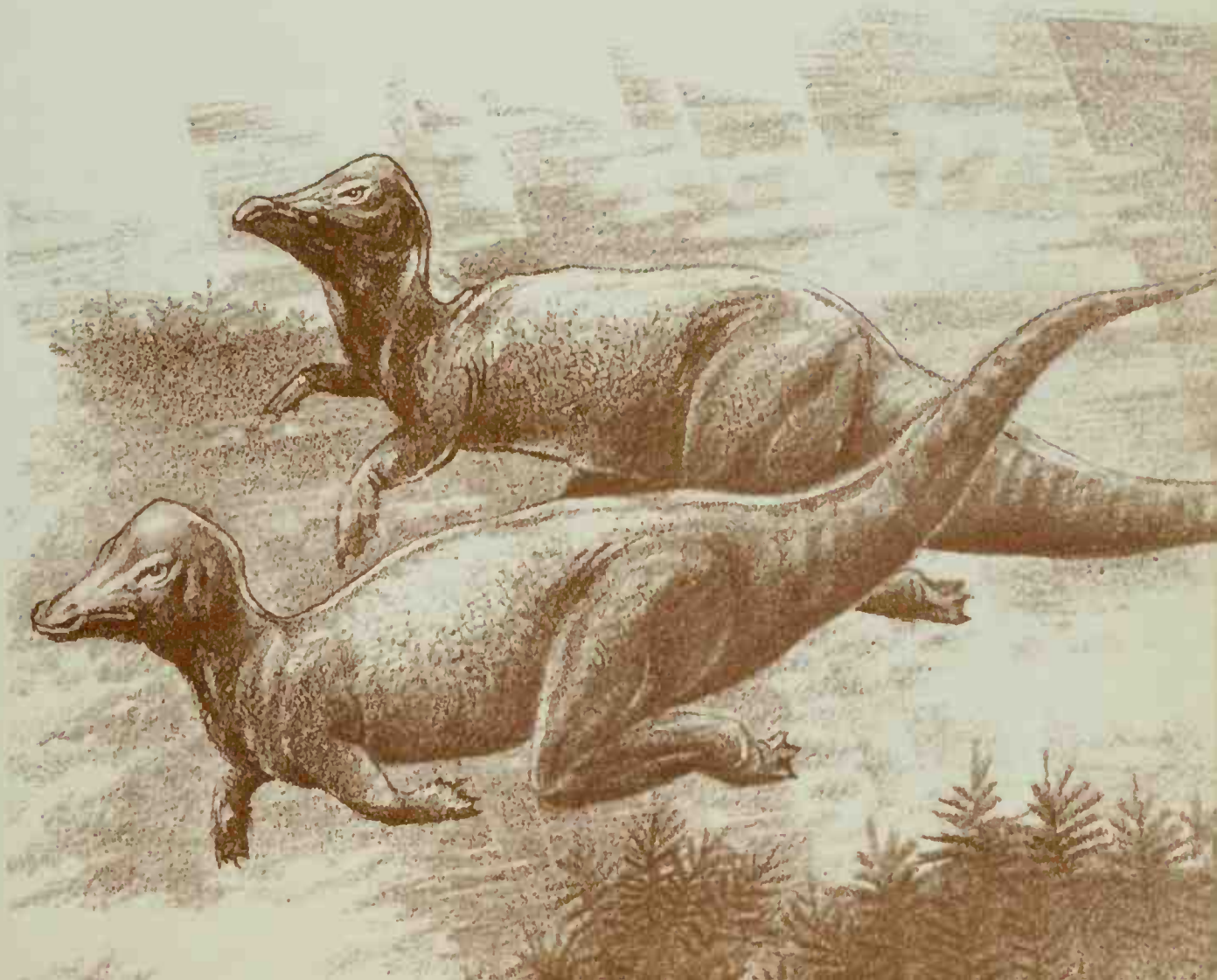


Procheneosaurus

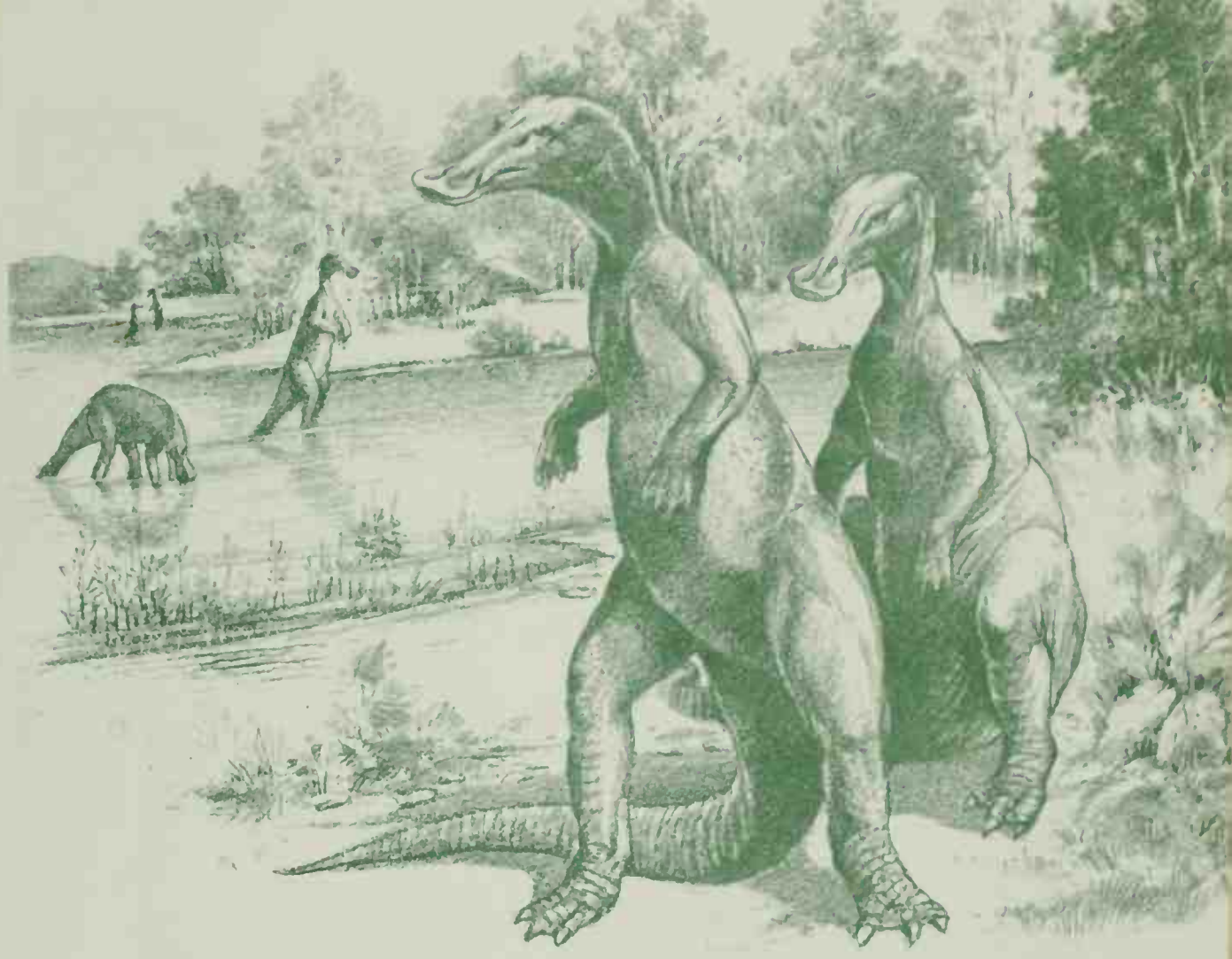
those of other dinosaurs. The fingers particularly seem to be built for grasping, and for this reason some paleontologists think that Hypsilophodon may have been a tree climber. Can't you picture this little dinosaur climbing about in the trees, munching on the leaves and fruits, well out of reach of all of his enemies?

The duck-billed dinosaur is well known to everyone who has studied or read about prehistoric animals. It has been nicknamed this because of its broad, toothless bill that looks very much like a duck's bill. The duck-billed dinosaurs have also been called hadrosaurs (HAD-roe-sawrs) and trachodonts (TRAK-o-donts). Perhaps we don't consider these dinosaurs as exciting as Tyrannosaurus or Diplodocus, but there are many strange things about these creatures. We know a great deal about these reptiles – perhaps more than we know about any other group of dinosaurs. That is because they were very common during the last part of the Cretaceous period and a great many of them have been found and placed on display in

Cheneosaurus



Corythosaurus



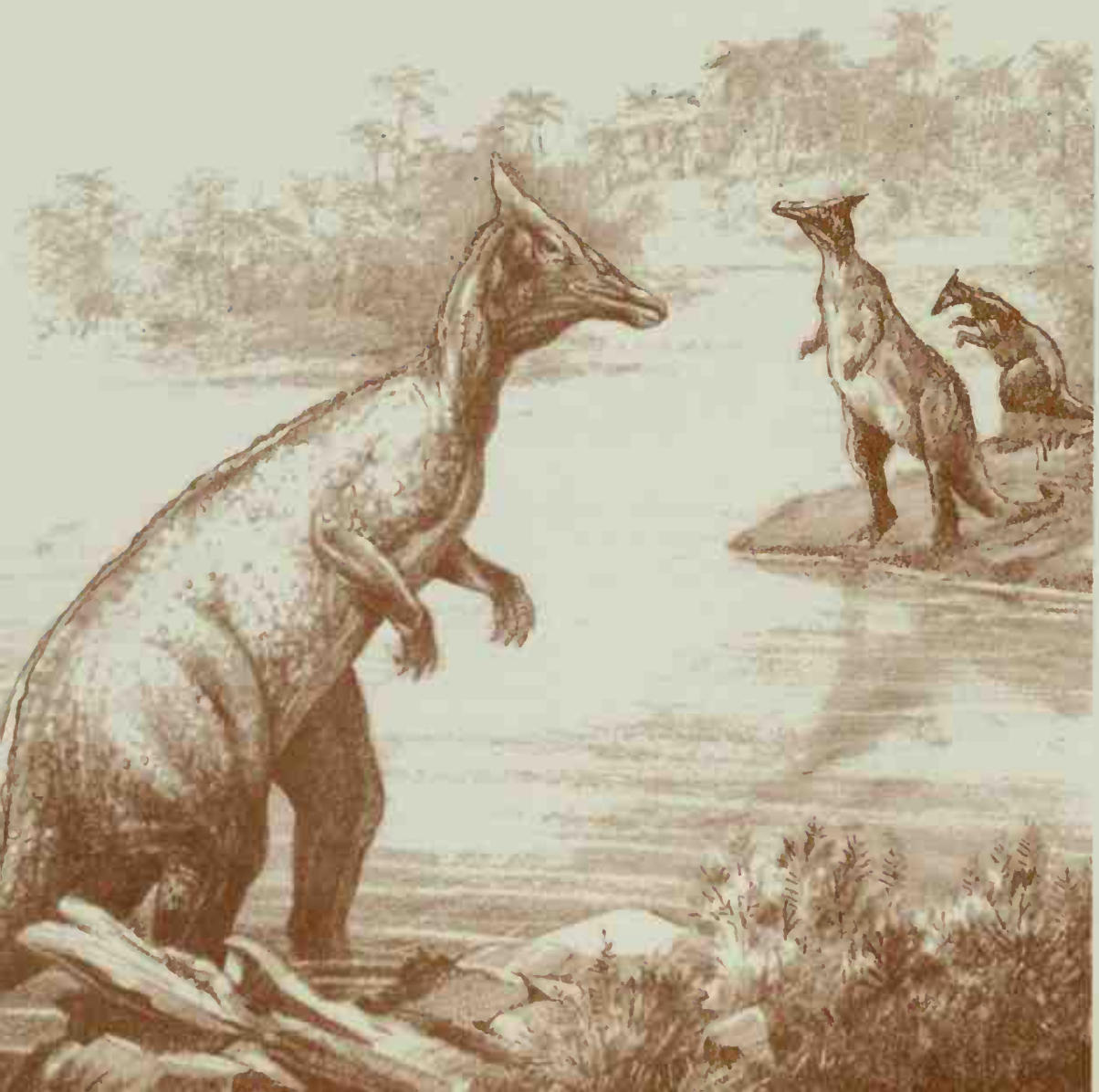
Anatosaurus

museums. But as you will see, there are still many things about the duckbills that we don't understand.

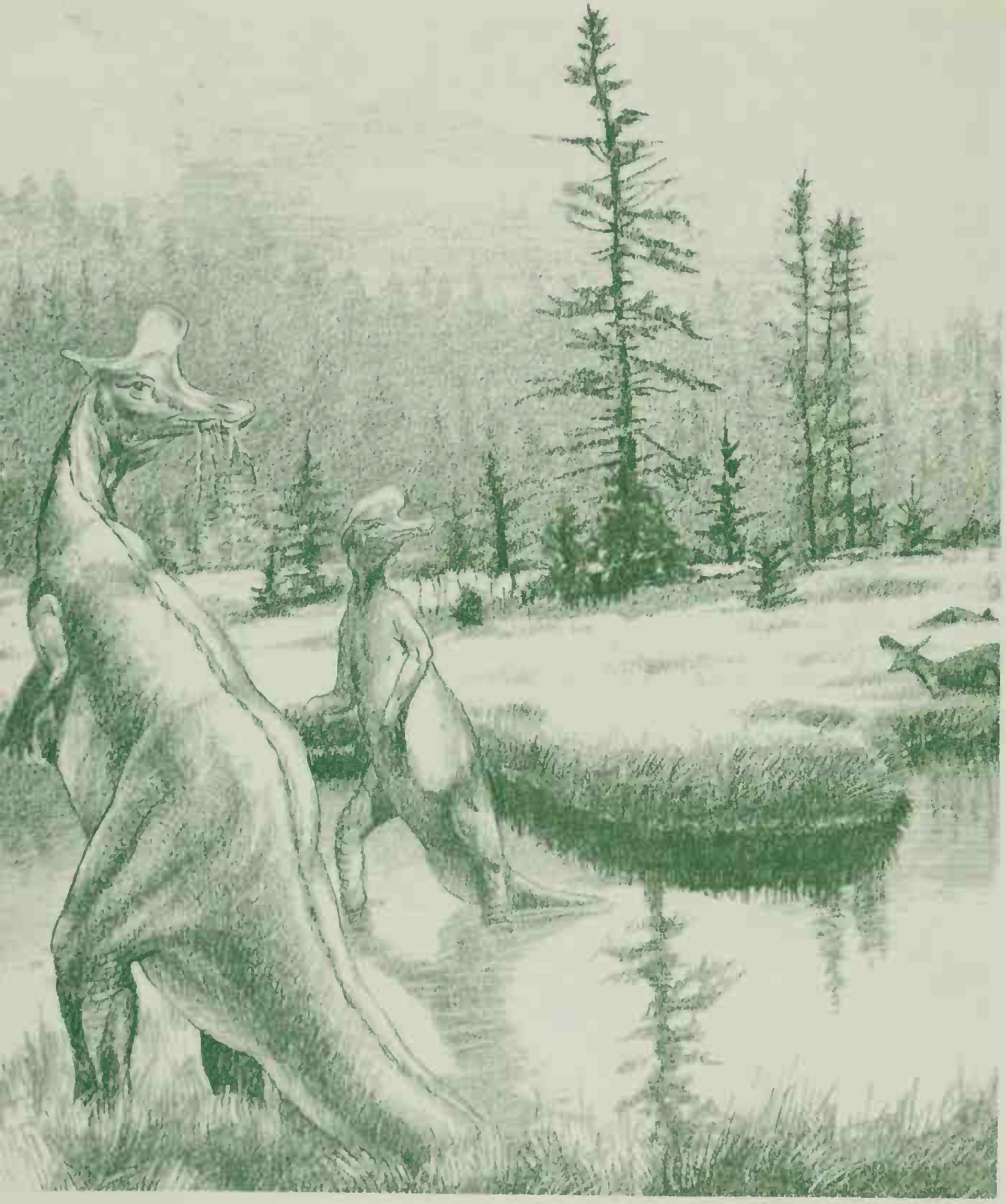
Not only were there a great many duck-billed dinosaurs, but there were many different kinds, as you can see by the many drawings here. The duckbills were ornithischians with a birdlike pelvis. As with the other ornithopods, the hind legs were much longer than the front legs, showing us that the duckbills could stand and walk in two-legged fashion. But, like Camptosaurus, they may also have used the short front legs for walking. Perhaps the duckbills walked about part of the time in a hunched-over pose like some of the other ornithopods we have already learned about. You have perhaps already noticed that these animals looked like Camptosaurus in many ways. This is not surprising, since the duck-billed dinosaurs probably evolved from Camptosaurus or one of its close relatives. But the duckbills were also different from Camptosaurus in many ways. Let us look more closely at the duckbills to see how they differed.

First of all, most of the duckbills were quite a bit larger than Camptosaurus. Some of them, like Edmontosaurus (ed-MON-toe-sawr-us) grew to a length of more than thirty-five feet, while Camptosaurus never got to be much more than half that long. Most of the duckbills were about thirty feet long, but there were some small ones like Procheneosaurus (pro-KEEN-ee-o-sawr-us) and Cheneosaurus (KEEN-ee-o-sawr-us) that were only about ten or twelve feet in length. All of the duckbills had long, heavy tails, but notice that these tails were very flat on each side. This is the kind of tail we see in crocodiles and alligators and for this reason paleontologists believe that the hadrosaurs were swimmers. In 1908, two very lucky discoveries were made in Wyoming when two "mummified" hadrosaurs were found. The muscles and flesh of course were not preserved, but because the bodies had become mummified and hardened before they were buried, impressions of both skin and muscles were preserved in the rock. These two hadrosaur mummies show us that the "hands" were

Saurolophus



Prosaurolophus



Lambeosaurus

Hypacrosaurus

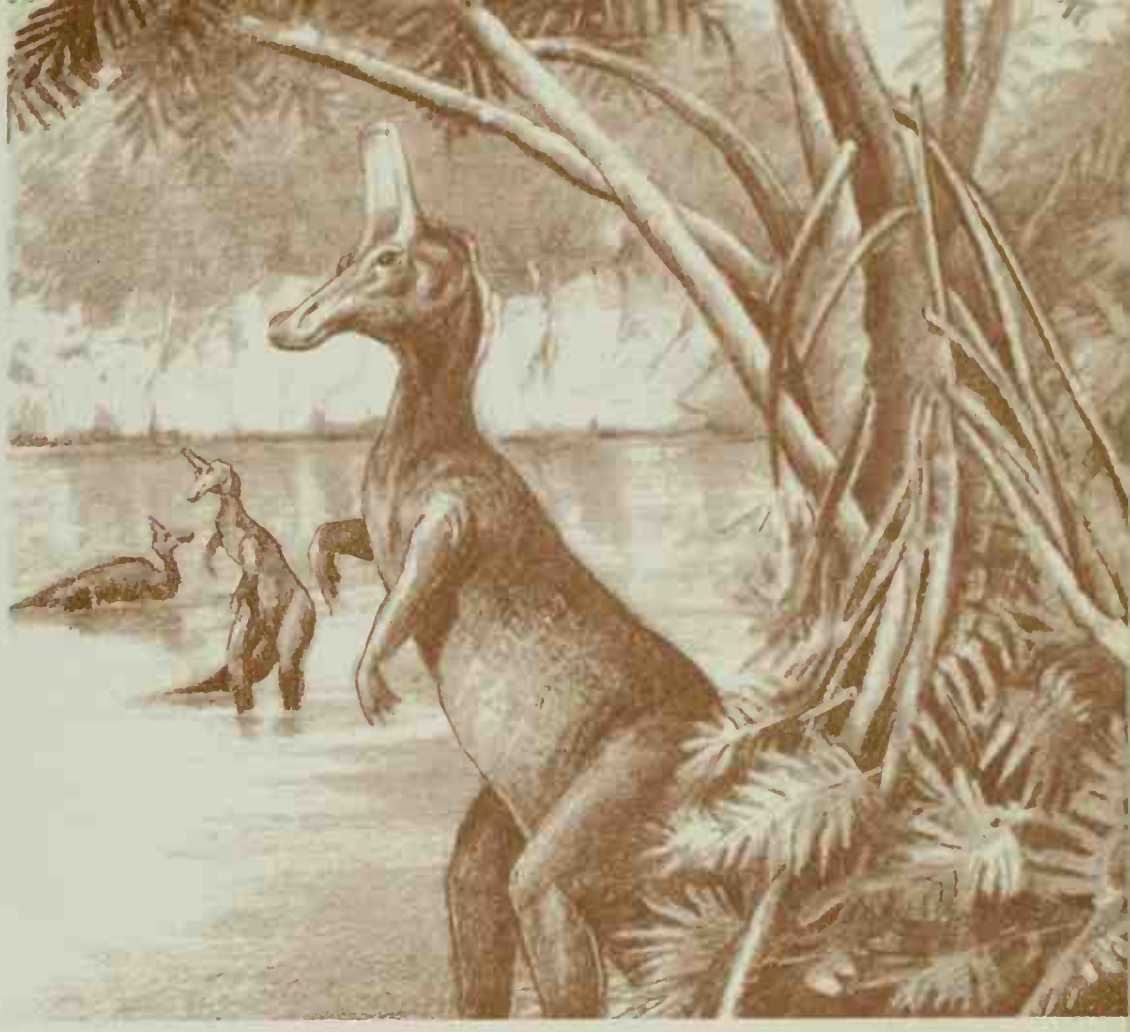
webbed, and it also looks as though the feet might have been webbed too. This webbing between the fingers and toes is very much like that in the feet of water birds such as ducks. So not only does the flat tail suggest that the duck-billed dinosaurs were swimmers, but so do the webbed feet.

But the hadrosaurs do not look much like other swimming animals we are familiar with. They look more like land animals and it seems likely that they were both — that is, they were amphibious like ducks or beavers or otters. Why would an animal like Trachodon (TRAK-o-don), more properly called Anatosaurus (an-AT-o-sawr-us), or Corythosaurus (kor-ITH-o-sawr-us) be amphibious? What reasons might a plant-eating, land animal have for going for a swim? One reason might be that it liked to eat water plants better than it did land plants. This is probably the most popular explanation, but the hadrosaurs may have taken to the water for another reason — to escape from danger. The hadrosaurs were rather unusual as dinosaurs go, because they seem to have been cheated when the weapons were handed out. Other dinosaurs had little to worry about because they were big and strong. But not the duckbills. They were not as large as some of the flesh eaters that were around. Some dinosaurs had sharp teeth or claws to fight with, but the duckbills didn't. Still other dinosaurs were built for speed and ran away from danger. The duckbills cer-

Left, Kritosaurus. *Right,* Parasaurolophus.

tainly weren't built for speed, though. There were other dinosaurs that had heavy armor or horns or spiked tails, but not the duckbills. How did the hadrosaurs defend themselves or escape from danger? With those swimming structures, my guess is that they took to the water where Gorgosaurus or Tyrannosaurus could not follow.

You have probably already noticed that some of the duck-billed dinosaurs had peculiar crests on top of their heads. These crests were made of bone and actually were part of the skull. Some of these crests, like those of Saurolophus (sawr-OL-o-fus) and Prosaurolophus (pro-sawr-OL-o-fus) were made of solid bone, but most of them were hollow. Inside the hollow crests are twisted canals and chambers that were connected to the nostrils and the windpipe. The nostrils were located at the tip of the snout, as in most animals. But when these crested duckbills breathed, the air went up into these chambers in the crests and then down into the windpipe and lungs. It is difficult for us to understand what these crests were used for and this is particularly true when we see all the many shapes and sizes that decorated the heads of certain duck-billed dinosaurs. Procheneosaurus and Cheneosaurus had very small crests, while Corythosaurus, Hypacrosaurus (hi-PAK-roe-sawr-us) and Lambeosaurus (LAM-bee-o-sawr-us) had very large crests. Most peculiar of all is the



Tsintaosaurus

great curved crest of Parasaurolophus (pair-a-sawr-OL-o-fus). And look at the weird crest of Tsintaosaurus (t-sin-TAY-o-sawr-us), one of the recently discovered duckbills from China.

Many theories have been suggested for the use of the crests, but so far no one has come up with an answer to satisfy everyone. The silliest idea is that these crests were used like hatchets for fighting. Since they were made of rather thin bone, this seems to be rather risky. The hollow chambers may have been used to hold an extra supply of air so the crested hadrosaurs could stay under water longer. But we can see that even the largest crests could not hold much air. Another idea is that they were used as a snorkle or breathing tube, but the nostrils were not at the end of the crest. There were no openings at the end of the crest. A recent suggestion is that inside these crests there may have been extra nerve cells for detecting odors. It might be that since the hadrosaurs had little means of protecting themselves, they had a keen sense of smell that helped warn them of approaching enemies.

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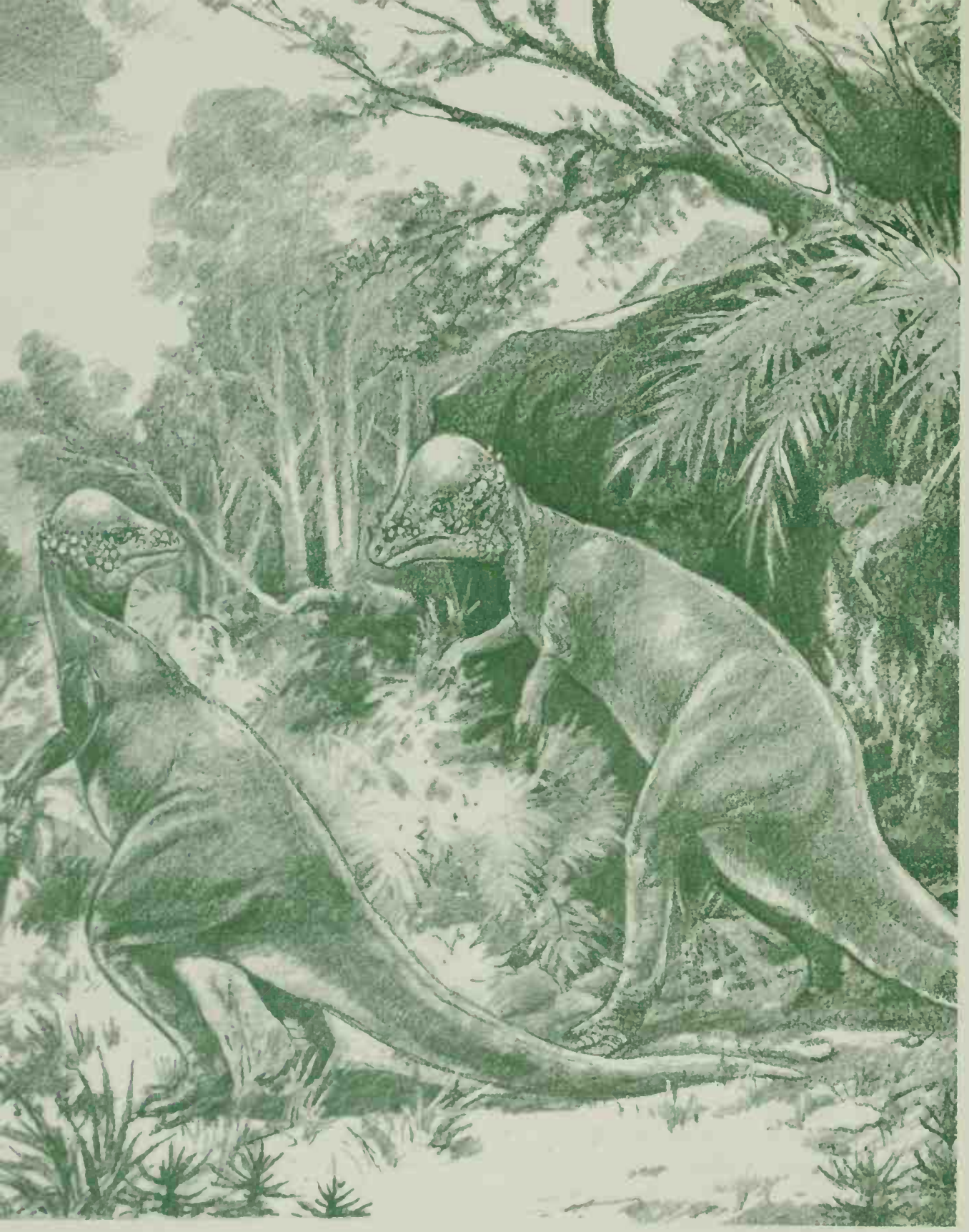


Pachycephalosaurus

Brachylophosaurus

But what about those other crests that were not hollow? What did Prosaurolophus, Saurolophus and Brachylophosaurus (brak-ee-LOFE-o-sawr-us) do with their crests? And what about those other duckbills like Anatosaurus and Edmontosaurus and Kritosaurus (KRITE-o-sawr-us) that had no crests at all? Why didn't these hadrosaurs have crests too? As you can see, there are still many mysteries about the dinosaurs. There are many questions still to be answered.

Leaving the hadrosaurs now, we come next to some unusual relatives of the duckbills. We might call these reptiles the "boneheads," for they had very thick, domelike heads. If the expression "thick-skulled" has any truth in it, then the troödonts (TRU-o-donts) were the dunces of all time. For these dome-headed dinosaurs had two or three inches or more of solid bone at the top of the skull. So far, only two different kinds of troödonts have been found, but there may have been others that haven't been discovered yet. The smallest "bonehead" is an animal called Stegoceras (steg-O-sair-us) or Troödon (TRU-o-don). The big "bonehead" is known by a tongue twisting name — Pachycephalosaurus (pak-ee-SEF-a-lo-sawr-us).

The "boneheads" looked a little like cousins of the hadrosaurs. They were rather heavy in their build and look as though they walked about on their hind legs. But they probably were not swimmers like the duckbills. And instead of the thin-boned, hollow crests, the troödonts had these great solid bony domes. What purpose do you suppose these domes were put to? The first idea that pops into our heads is that

Psittacosaurus

they were used as battering rams. But can you imagine two of these creatures butting their heads together? What terrible headaches they must have had! And what crashing noises must have echoed through those Cretaceous forests! But goats and deer and moose do this sort of thing, so why not troödonts?

Almost unnoticed among the Cretaceous ornithopods is a small, bipedal plant eater called Psittacosaurus (sit-a-ko-SAWR-us). It does not seem very important to us and it probably didn't make much of an impression on the other dinosaurs of its day. But it is a very important little dinosaur, for Psittacosaurus was probably very closely related to the ancestors of all the horned dinosaurs. It lived during the early part of the Cretaceous period in Asia. Its short front legs show us that it too walked in a two-legged fashion like all of the other ornithopods. In this respect, it looks quite different from the four-legged horned dinosaurs that came later. But it had the same parrot-like beak that all of the horned dinosaurs had. And it had the beginnings of a neck shield like the true horned dinosaurs. In fact, if the front legs were longer, so that we could see that it walked on four legs instead of two, we would probably call it a ceratopsian (sair-a-TOP-see-yan) dinosaur.

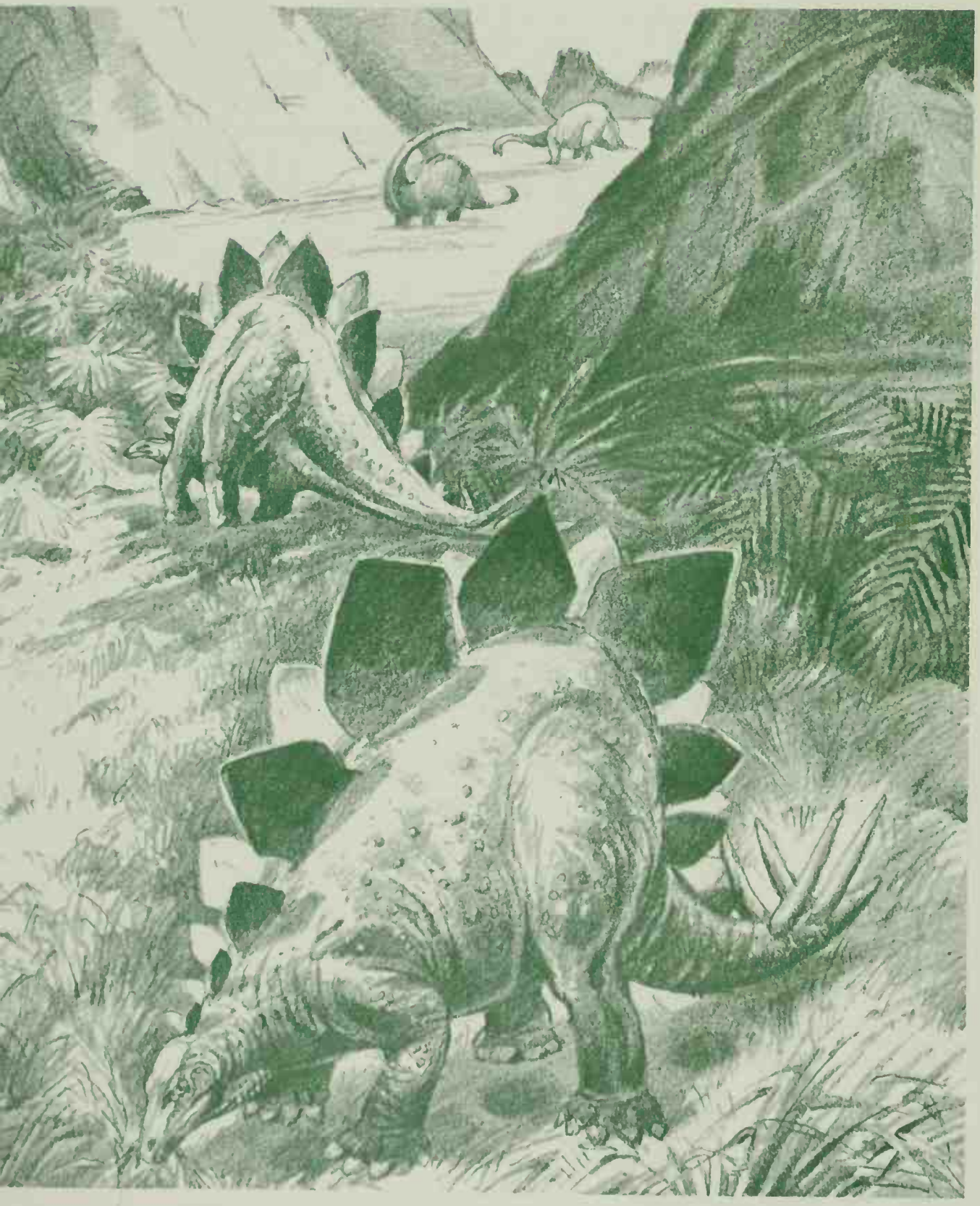
The plate-backed dinosaurs

Stegosaurus is a favorite of everyone. This is not because of its good looks, but because it was the most absurd-looking of all creatures. Who would ever imagine such a silly-looking animal if we didn't have the bones to prove it? Yet there it is —

or there it was back in the days of the Jurassic period – almost as big as an elephant. Look at that great blimplike body on those postlike legs. And where is the head? It is unbelievably small for such a large animal. We almost get the feeling that Stegosaurus' head just didn't keep up with the rest of him while he was growing. And that is exactly right. We all know that inside that head there was almost no brain at all. In fact, the brain was so small that you could have held two or three of them in one hand. It was not much bigger than a walnut. In spite of the lack of brains, however, the stegosaurs were very successful animals. They roamed over western North America for several million years. Their bones have been found particularly in the states of Wyoming, Utah, Colorado and New Mexico.

Strangely enough, although lots of stegosaur bones have been found, there are still many questions about them that cannot be answered. First, what were the tri-

Stegoceras (or Troödon)

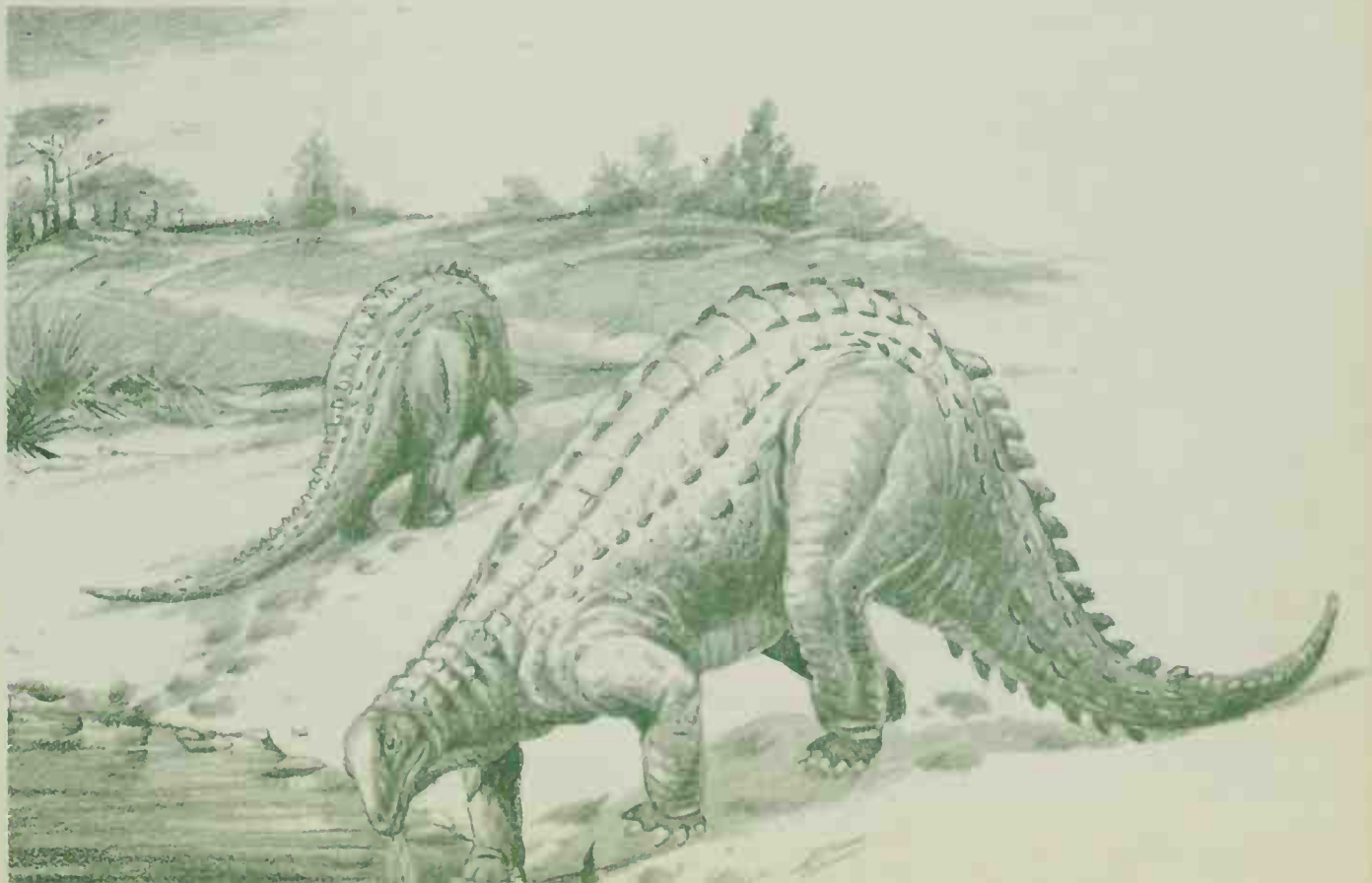


Stegosaurus

angular bony plates for? Were they for protection against the meat eaters that lived then? If so, how was the rest of the back protected? Another question is: How were these plates arranged along the back? We are quite sure that they stood on end, as the artist has shown them here, but were they in a single row down the back, or were they in two rows? If they were in two rows, were they arranged in pairs or did they alternate on each side? One skeleton shows them in two rows. If this is right then we would expect the plates to be arranged in twos – side by side. When we look at other vertebrates, we find that features that occur in twos are paired; that is, one is like the other and they occur on each side opposite each other – like two ears or two hands, or the ribs on opposite sides. But in Stegosaurus, two plates the same size have never been found. And at least one stegosaur skeleton has been found where these plates do not seem to lie opposite each other. Instead they seem to alternate – first on one side and then on the other – in two rows down the back. This is very strange, for no other vertebrate has such lopsided anatomy.

Stegosaurus was most likely a rather quiet plant eater. Lumbering through the brush and forests, he wanted no trouble from Antrodemus. But sometimes Antrodemus came looking for food – and trouble. And we can be sure that it sometimes was Stegosaurus that he found. As strange as he was, Stegosaurus still had the means to discourage his enemies. Near the end of that heavy tail were four long, sharp spikes. We can imagine Stegosaurus looking back behind at a hungry Antrodemus,

Scelidosaurus



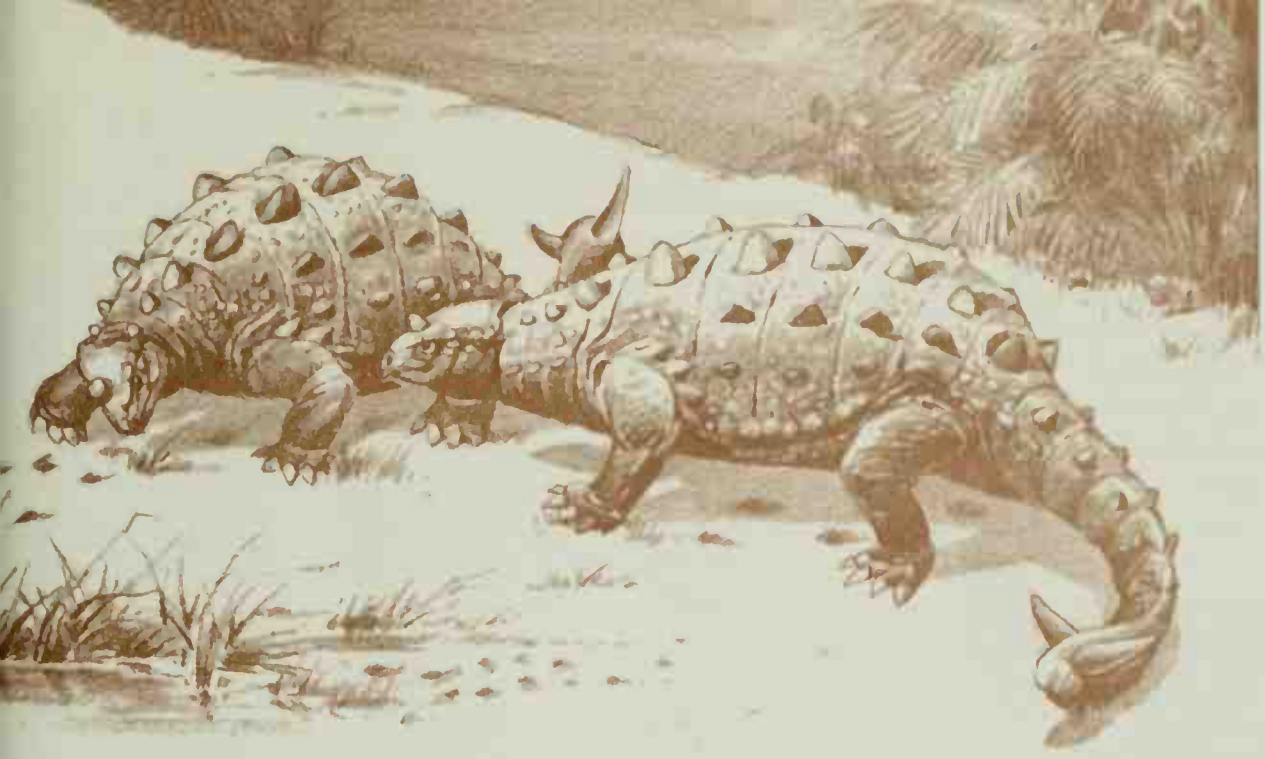
Left, Ankylosaurus (or Euoplocephalus). *Right,* Palaeoscincus.

and lashing out with that spike-covered tail. As Antrodemus moved around to the side to avoid those spikes, Stegosaurus kept turning so that tail was always aimed at his enemy. Antrodemus probably never did get a chance to look Stegosaurus straight in the eye. All he got to see were those spikes whipping back and forth in front of his face.

While Stegosaurus was munching his leaves in North America, other stegosaur-like dinosaurs were doing the same in Europe, Asia and Africa. The stegosaurs were well-traveled animals. One of the relatives of Stegosaurus is a creature called Scelidosaurus (skel-EE-doe-sawr-us). This creature lived in England and western Europe a few million years before Stegosaurus roamed the countryside of North America. As you can see, it was a more normal-looking animal, although it still looked like its North American cousin. Scelidosaurus had a somewhat larger head and instead of the large, edgewise plates down its back, there were much smaller bony plates all over the back and down the flanks. These seem to be a better kind of protection than the plates of Stegosaurus. But Scelidosaurus did not have those handy spikes on the tail. Perhaps Scelidosaurus was not as much of a fighter as Stegosaurus seems to have been.

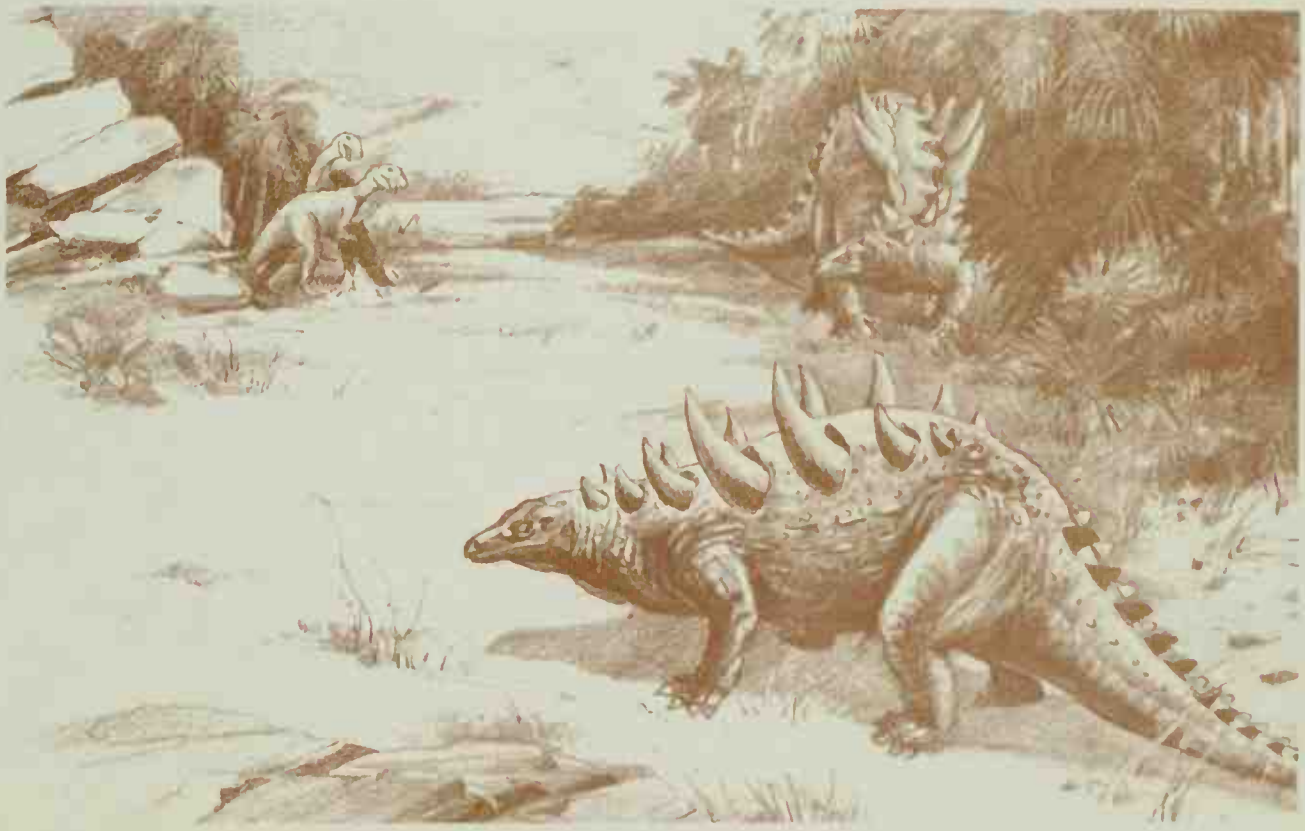
The armored dinosaurs

If the bony armor of Scelidosaurus seems well built, take a look at the armor of the ankylosaurs (an-KILE-o-sawrs). We might call them the tank reptiles, because they had a heavy shield of armor just like an army tank. This armor plating was very



Scolosaurus

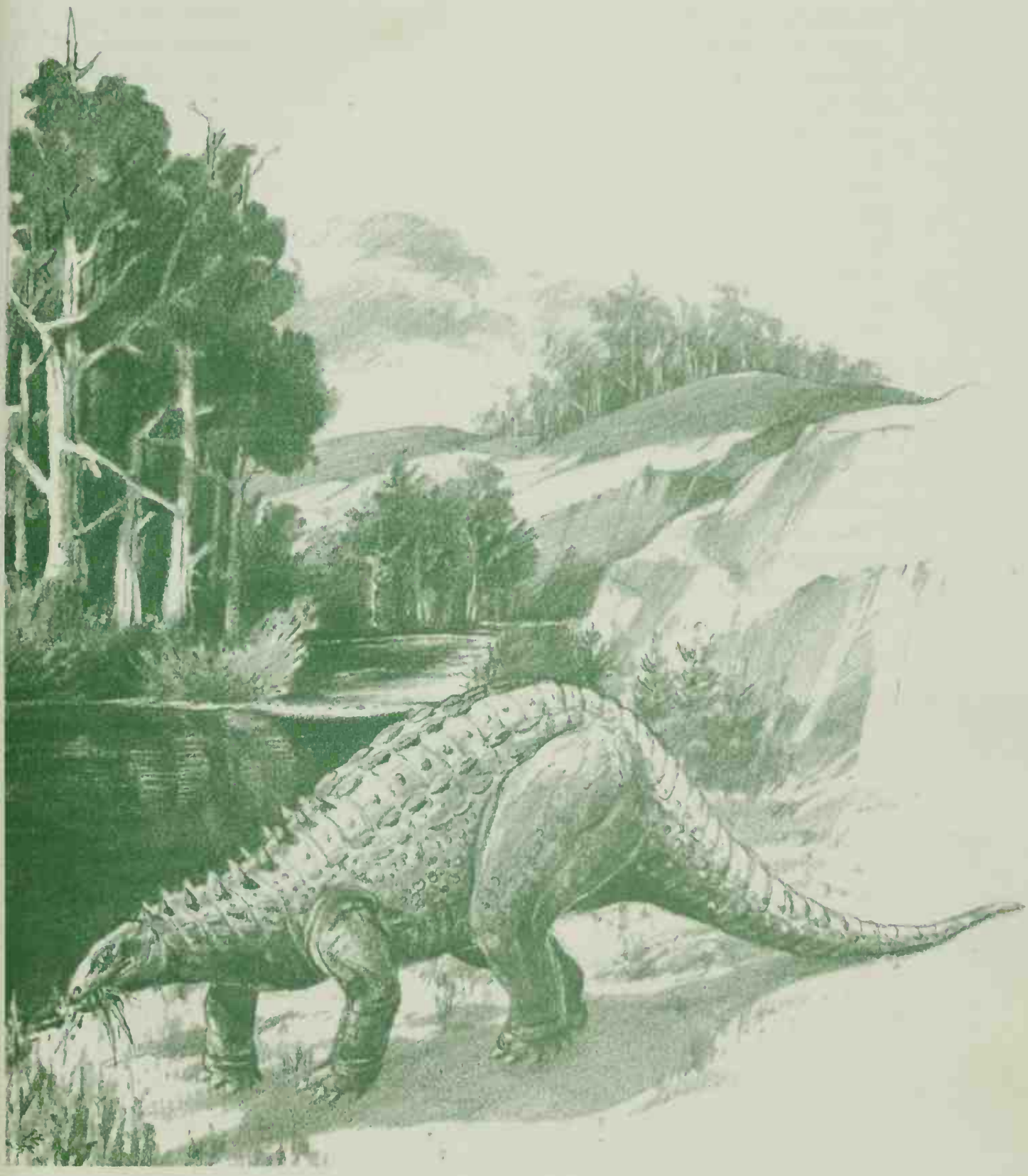
Polacanthus



necessary to the ankylosaurs, because they had to constantly watch out for the worst of all meat eaters – Gorgosaurus and Tyrannosaurus. The ankylosaurs' armor must have been quite successful, for many different kinds of armored dinosaurs lived all over the world during the Cretaceous period. And they lived for many millions of years before finally becoming extinct. Yet this armor does not seem to be quite enough protection against Tyrannosaurus. It is not difficult to imagine Tyrannosaurus rushing at Palaeoscincus (pale-ee-o-SKINK-us). One great kick of a powerful hind leg flips Palaeoscincus over on his back. And with the soft belly exposed, Tyrannosaurus makes short work of Palaeoscincus. But, wait a moment. Perhaps those big spikes at the shoulders and along the sides of Palaeoscincus would discourage Tyrannosaurus. Perhaps Palaeoscincus was not such an easy meal after all.

Nor would Ankylosaurus (an-KILE-o-sawr-us), sometimes called by the difficult name Euoplocephalus (you-o-plo-SEF-a-lus), be an easy meal. In fact, most of the armored dinosaurs had large spikes along the sides of the body or on the back. These spikes must have made it rather dangerous for any would-be attackers. So Scolosaurus (SKOLE-o-sawr-us), Polacanthus (pole-a-KAN-thus) and Syrmosaurus (SEER-mo-sawr-us) fed quietly, knowing that the meat eaters would get their cuts and bruises if they attacked. And as we look closer we see that the ankylosaurs had other means of protecting themselves. Ankylosaurus, for example, had a large mass of bone at the end of its tail. This was probably used as a club against its enemies. Other armored dinosaurs, such as Nodosaurus (NO-doe-sawr-us), may have had spikes on the tail, much as Stegosaurus had. Again it seems that Tyrannosaurus and the other flesh eaters of that time had a dangerous task in getting their meals. The armor plates, the shoulder and back spikes, and the tail clubs and spikes were good protection against these larger enemies.

Syrmosaurus



Acanthopholis

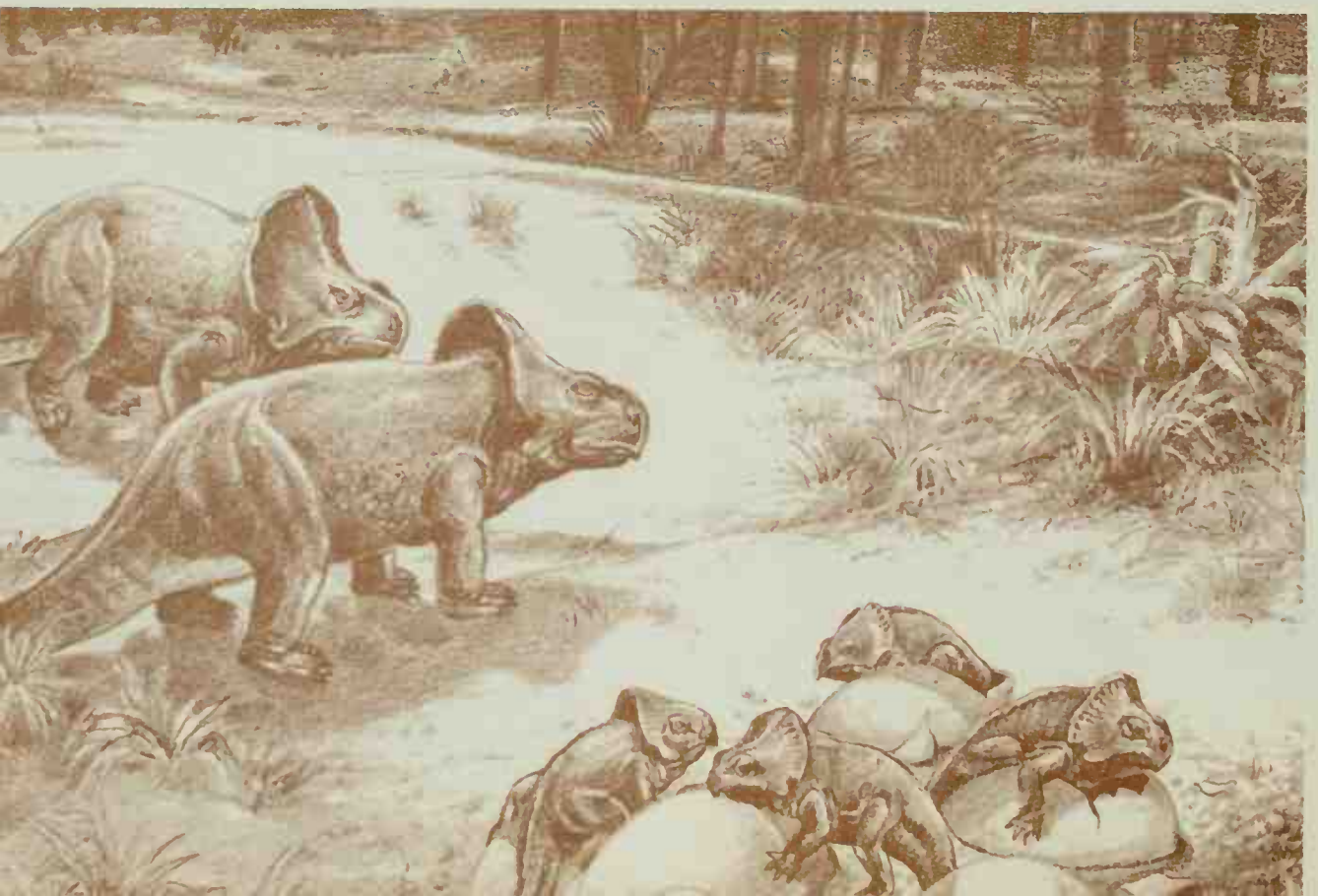
The armored dinosaurs lived all over the world for many millions of years. Acanthopholis (a-KANTH-o-fole-iss), and Polacanthus roamed about the European continent and Syrmosaurus lived in Asia. Ankylosaurus, Scolosaurus, Nodosaurus and Palaeoscincus lived in North America.

The horned dinosaurs

We have learned about almost all of those prehistoric animals that we call dinosaurs, but there is one group left – the horned dinosaurs or ceratopsians. These reptiles lived about the same time as the armored dinosaurs, during the Cretaceous period. They are of special interest, for the horned dinosaurs were among the last of the dinosaurs – perhaps the very last ones to become extinct. They are of interest also because there were so many different kinds, although only ten of the ceratopsians have been pictured here by the artist. There are many other kinds that are known from fossil bones, but not enough of these other kinds have been found yet to show us what they looked like. Most famous of the horned dinosaurs is Triceratops (tri-SAIR-a-tops). Before we learn about this creature, though, let's look at some of the other ceratopsians that lived a little earlier.

Much is known about the evolution of these animals. We have already seen a little creature from Asia called Psittacosaurus that may be very closely related to the ancestors of all the horned dinosaurs. But we know more about the ancestry of

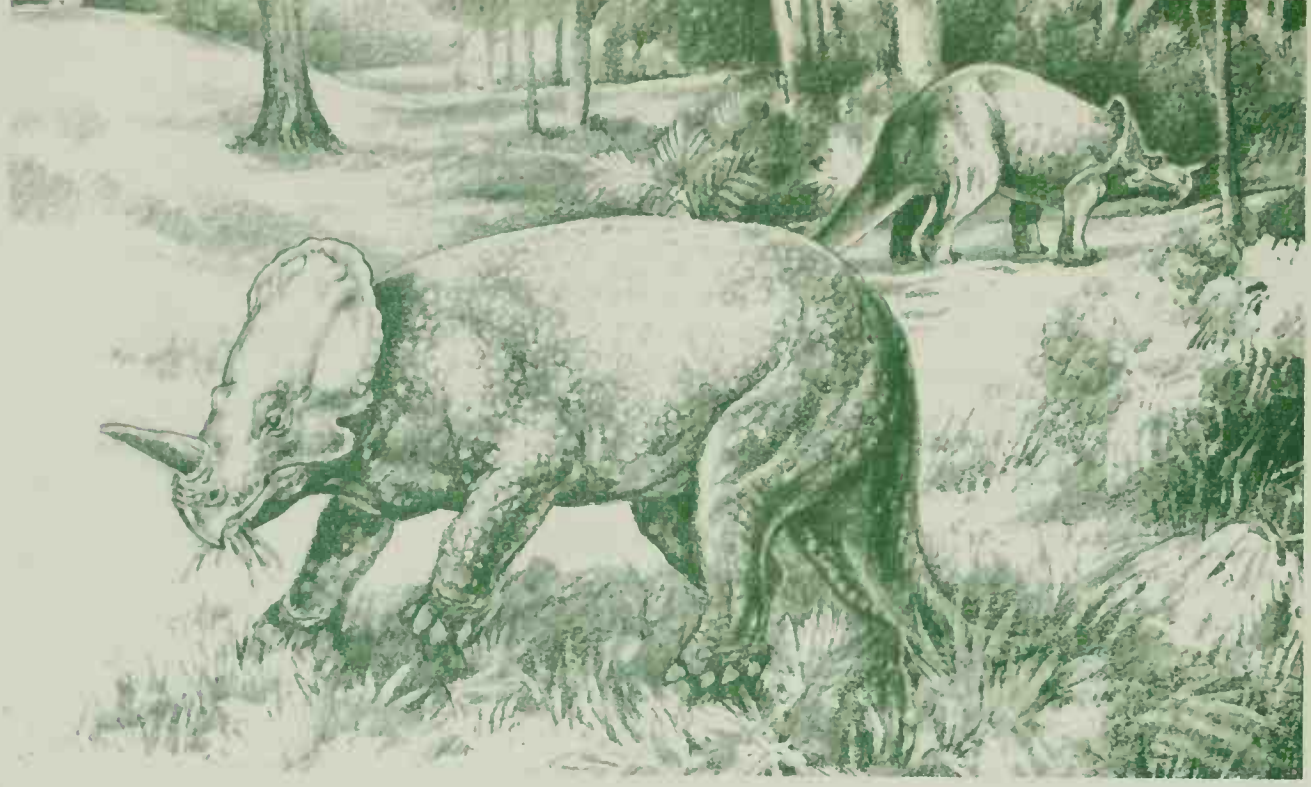
Protoceratops



the ceratopsians. A now very famous expedition to Mongolia by paleontologists of the American Museum in New York made some amazing discoveries that tell us a great deal about the horned dinosaurs. The first of these was the discovery of many skeletons of a little ceratopsian, which they named Protoceratops. This name means "first horn face" and it is quite appropriate, for Protoceratops is the first or oldest of the known ceratopsians. But there was a strange thing about this animal – it had no horns like Triceratops or Monoclonius (mon-o-KLONE-ee-us). Protoceratops was a very primitive member of the family and had not yet grown the horns that all of the other ceratopsians are famous for. It was like its larger horned relatives in other ways, though. It had the same parrot-like beak and it had a medium-sized neck shield that reached back behind the head. And unlike Psittacosaurus, it walked in four-legged fashion like all true ceratopsians. Here was a true ancestor of Triceratops and the other horned dinosaurs.

This same expedition made an even more exciting discovery, as many of you may know. Besides the many skeletons of full-grown and baby Protoceratops, they discovered the treasure sought by every paleontologist – dinosaur eggs! And not just two or three eggs, but whole nests of eggs, Protoceratops eggs. Since that time, eggs of other dinosaurs have been found in other places, but nothing can match this first discovery of real dinosaur eggs. It proved what paleontologists had been saying for many years – that dinosaurs had been egg layers, like most modern

Nodosaurus



Monoclonius

Styracosaurus

Chasmosaurus

reptiles. You can imagine how much excitement this discovery stirred up. These nests of Protoceratops eggs are now on display at the American Museum in New York City.

Protoceratops had many descendants that lived in many parts of the world. But it seems that most of the horned dinosaurs lived right here in North America. Monoclonius is one of the earliest of the North American ceratopsians. This ancient reptile was quite large, measuring more than sixteen feet in length. The head was also large and extending back over the neck was a large collarlike shield or frill made of bone. This strange collar must have protected the vital neck region, but it also served as a frame for the large neck muscles that were necessary to hold the head up. This frill also provided for the attachment of the large muscles that closed the jaws and chopped up the food. Monoclonius had the usual parrot-like beak similar to that of Protoceratops. It also had a single large horn on its nose just in front of the eyes and a small horn just above each eye.

A slightly larger ceratopsian that lived at the same time was Styracosaurus (stie-RAK-o-sawr-us). This creature looked very much like Monoclonius with its one large horn on the nose and two very small horns, one over each eye. But the collar

Anchiceratops

Pentaceratops

Pachyrhinosaurus

Torosaurus

shield was much longer in Styracosaurus and it had great spikes sticking out from its edge like the spokes on a wheel. Chasmosaurus (KAZ-mo-sawr-us) was a close relative and neighbor of Monoclonius and Styracosaurus. The shield of Chasmosaurus, though, was a great deal longer than that of either of these. And Chasmosaurus had three horns on its head, two long ones above the eyes and a single shorter one on the nose.

Chasmosaurus had several descendants that looked very much like him. Anchiceratops (AN-chi-sair-a-tops), with its long flat shield and three horns like Chasmosaurus, is likely to be confused with its ancestor. Pentaceratops (PEN-ta-sair-a-tops), however, is easily recognized. Not only was it much larger than most of the other horned dinosaurs, but it had a very long shield that reached high up over the

Leptoceratops

neck. It was named Pentaceratops because of the five horns on its head. Two long horns above the eyes, a shorter horn on the nose and a large horn on each cheek made Pentaceratops a well-armed fighter.

Living at the same time as Anchiceratops and Pentaceratops, was a much smaller ceratopsian called Leptoceratops (LEP-toe-sair-a-tops). This reptile looks very much like Protoceratops in many ways and it was not much larger than Protoceratops, only about six feet long. It had no horns, but it did have the neck frill and the parrot-like beak. Pachyrhinosaurus (pak-ee-RINE-o-sawr-us) was a most strange kind of ceratopsian. It had a funny rough plate of bone on its nose which looked almost as if someone had set a large lump of cement on its nose to harden. No one knows what this was for, or why Pachyrhinosaurus had this instead of a horn. It may be that this feature was not natural and that Pachyrhinosaurus had a bad nose infection. But this does not seem likely.

The last of the ceratopsians were the well-known Triceratops and the giant Torosaurus (TOR-o-sawr-us). Both of these dinosaurs had great long horns above the eyes and a single horn on the nose. Both had long bony shields over the neck, but that of Torosaurus was very long. In fact, the head of Torosaurus measured more than eight feet from the tip of the snout to the end of the shield. That was nearly half the length of the whole animal. The horned dinosaurs were probably the last of

the dinosaurs to die out. This does not mean, though, that the ceratopsians were failures. Just the opposite is true. As we have seen, there were many different kinds and they lived in great numbers for millions of years. Horns, like those of the ceratopsians, were good weapons, and we can imagine how Triceratops and his many relatives used them against their enemies. Tyrannosaurus and Gorgosaurus found no easy pickings here.

Triceratops

6

Other Prehistoric Reptiles

We have seen and read about the many kinds of dinosaurs, but this is not the end of the world of the dinosaurs. There were many other ancient reptiles besides the dinosaurs. The rest of this book is about these other creatures of the past. Before we look at them, though, we must remind ourselves that they should not be called dinosaurs. Some of them are related to the dinosaurs and others may look to you like dinosaurs. But they really were quite different. For one thing, they do not have the right kind of hip structure. For another, the skull is most often not of the diapsid type. But, even though these other animals cannot be called dinosaurs because of anatomical differences, they are still of great interest to us, for many of them lived during the age of dinosaurs and are as strange and frightening as the dinosaurs.

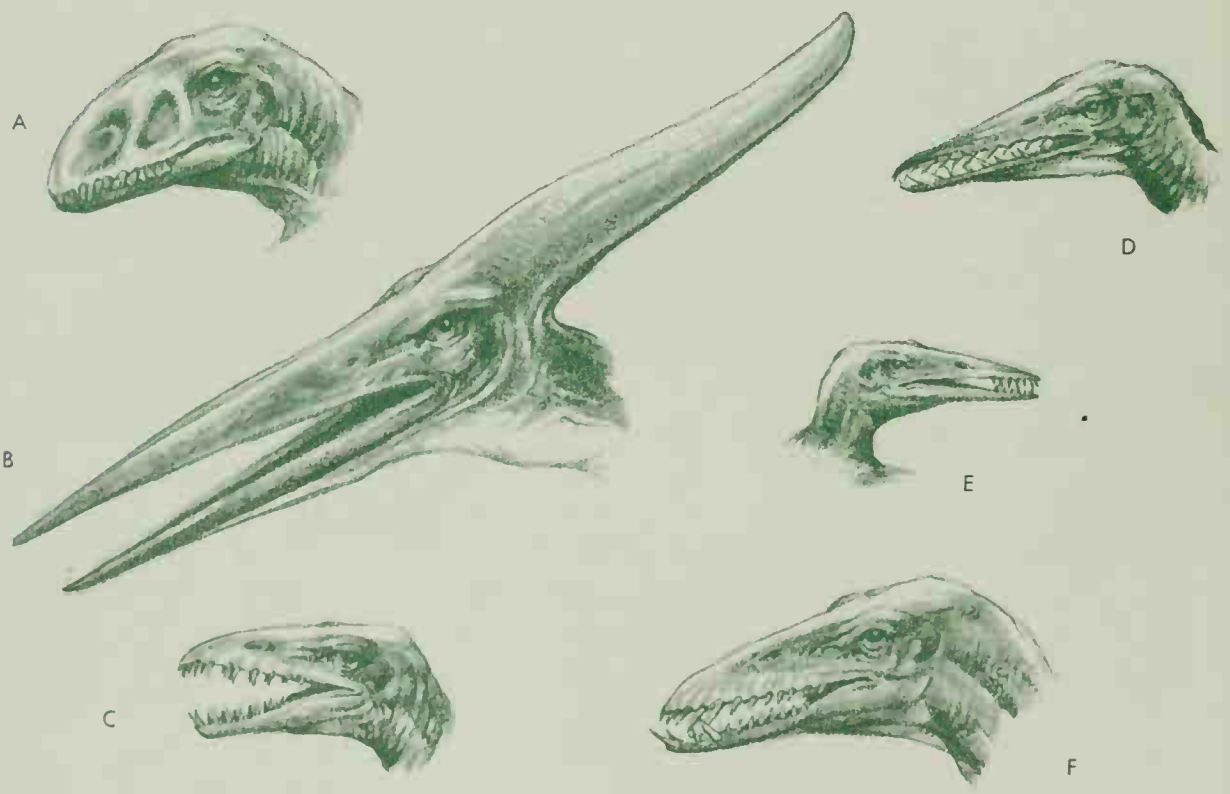
The flying reptiles

If we didn't know better, we would laugh at anyone who talked of reptiles flying. Reptiles are built for crawling or running and some for swimming, but a flying reptile seems impossible. Yet we know that it happened. Of course there are none alive now — unless you count a small gliding lizard called Draco (DRAY-ko). But during the age of the dinosaurs, the Jurassic and Cretaceous periods, there were some of the strangest creatures of all time. These were the flying reptiles or pterosaurs (TAIR-o-sawrs). The name pterosaur is a good one for it means "wing lizard" or "wing reptile."

Most of the fossils of pterosaurs have been found in Europe – and especially in a particular kind of rock that occurs in southern Germany. Some of these animals have been found in other parts of the world, such as in Africa and our own great plains states of Kansas and Nebraska. But most have been discovered in a limestone in Germany. The reason this is so is quite simple. The pterosaurs were built to fly and for this reason most of their bones were hollow so that the skeleton was as light as possible. Such delicate bones are only rarely preserved as fossils and only very special rocks preserve them without their being crushed. One of the best of these special rock kinds is the Solonhofen limestone of Germany. Another is the Niobrara limestone of Kansas. Understanding that we can expect to find such delicate fossils only where these special rock types occur, then we can suppose that pterosaurs once flew over most of the lands and waters of the world, but have only been preserved for us to find in a few special places where the right kind of rock was deposited.

Although the pterosaurs were flyers and looked very birdlike in many ways, they were not birds. They had no feathers and they did have many reptilian structures in their skeletons. They were true reptiles that had taken to the air. Some of

Pterosaurs, the flying reptiles

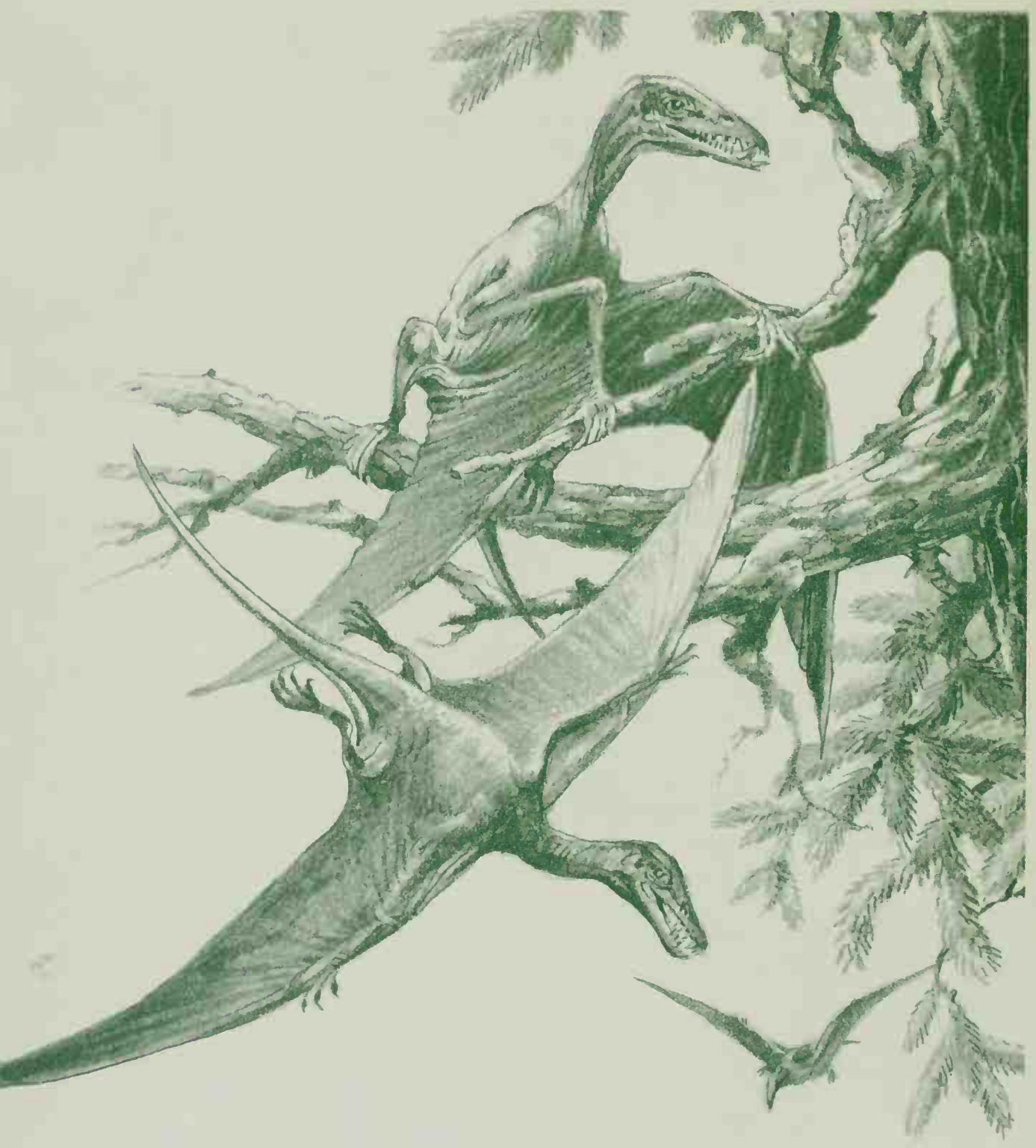


A Dimorphodon
B Pteranodon
C Scaphognathus
D Rhamphorhynchus
E Pterodactylus
F Dorygnathus

Pteradactylus

Left corner, Rhamphorhynchus. *Upper right,* Dimorphodon.

Pteranodon

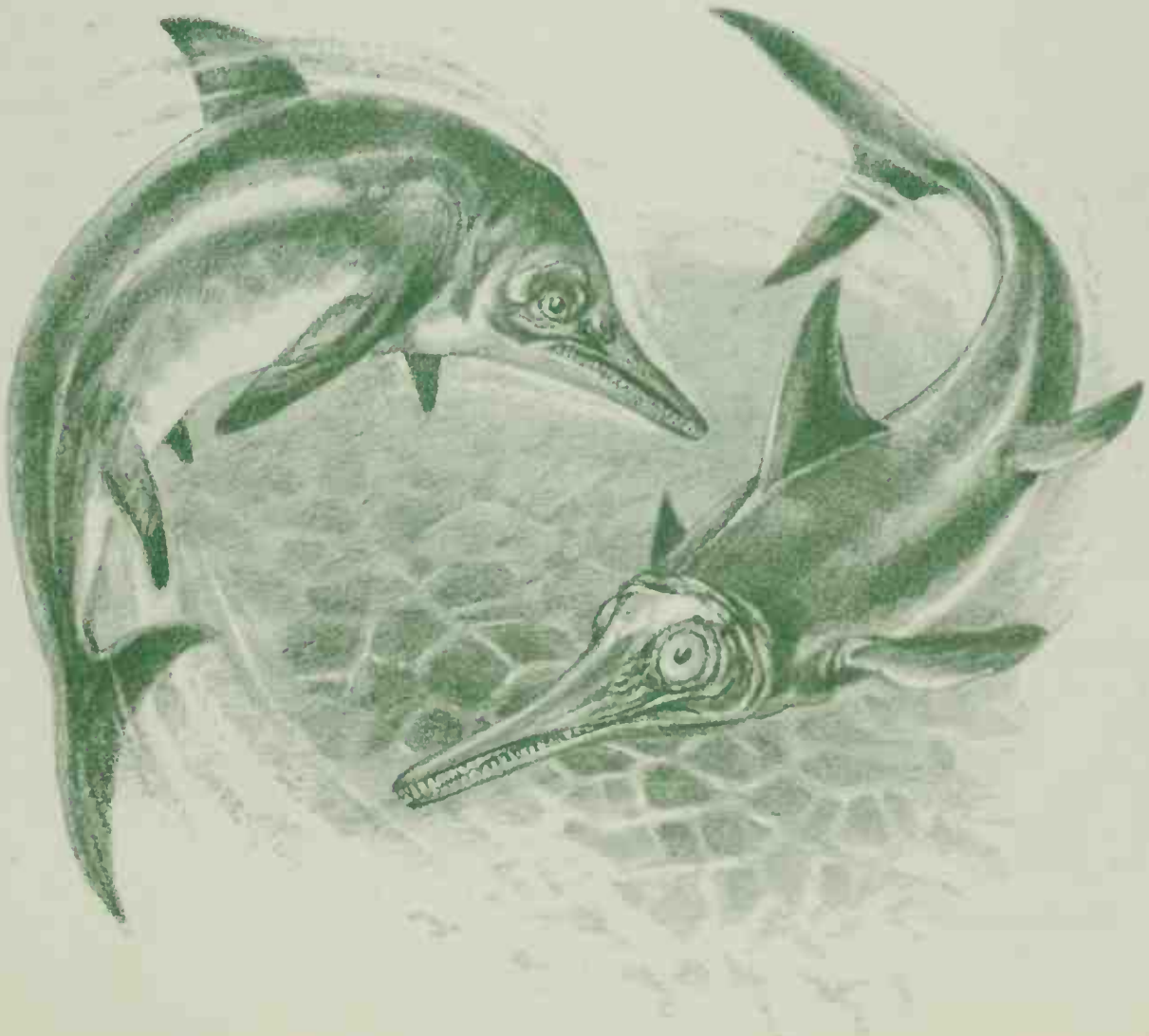


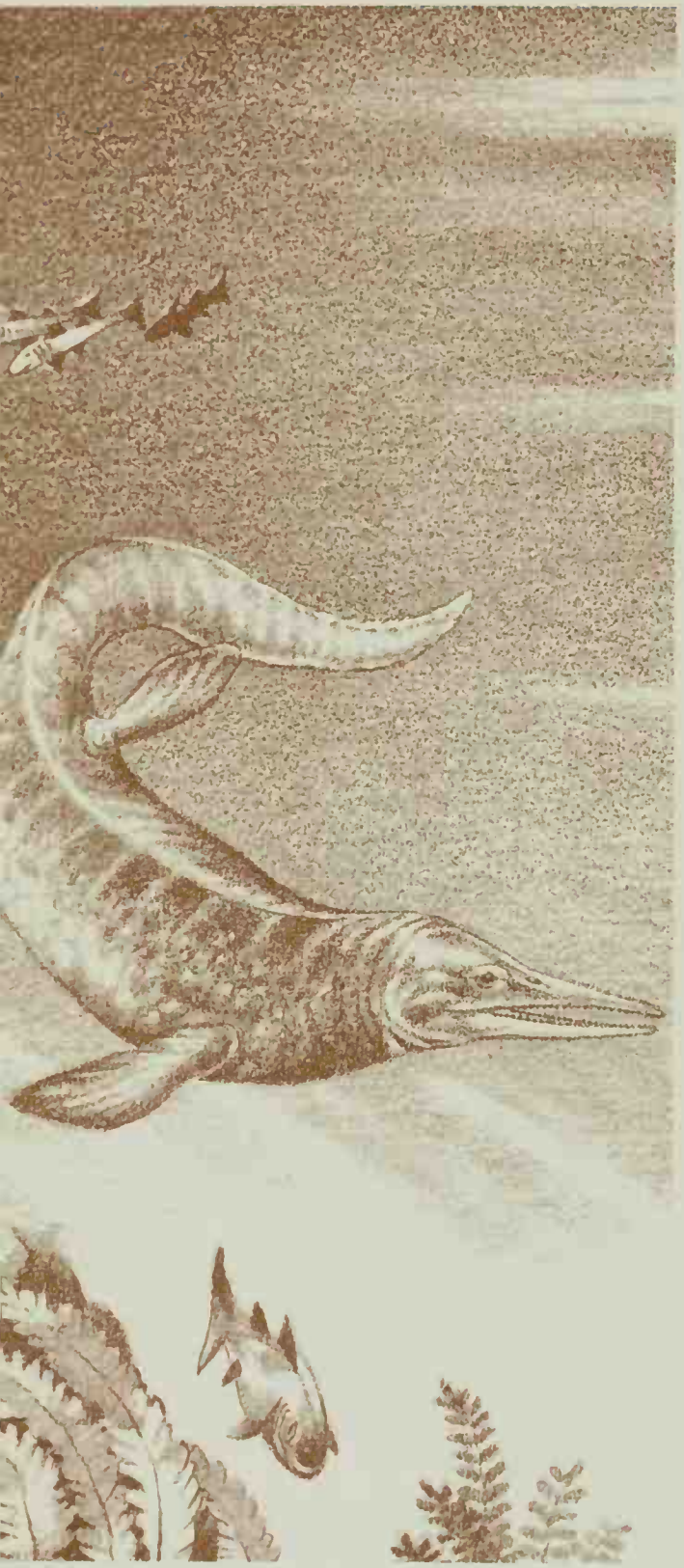
Scaphognathus (flying). Dorygnathus (on tree limb).

them, like Pterodactylus (tair-o-DAK-tee-lus), were quite small – about the size of a dove or a robin. Others, like Rhamphorhynchus (ram-for-RINK-us), were about the size of a large rooster. And Pteranodon (tair-AN-o-don) of Cretaceous times had a wing span of more than twenty-five feet. This is larger than any known flying bird, by many feet. Dimorphodon (die-MORF-o-don), Dorygnathus (dor-ee-NAY-thus) and Scaphognathus (skaf-o-NAY-thus) are some other less well known kinds of pterosaurs of the Jurassic period.

As you can see, there were many different kinds of pterosaurs. There are still others that are too poorly known to permit an artist to reconstruct them for you. From what we do know about these flyers, though, it is probable that most of them were fish eaters, somewhat like the modern heron or pelican, and we can be quite sure that they were good flyers. But, in spite of their long wings, the pterosaurs may not have been as good at flying as are these modern water birds. This of course is

Left, Stenopterygius. *Right,* Ophthalmosaurus.

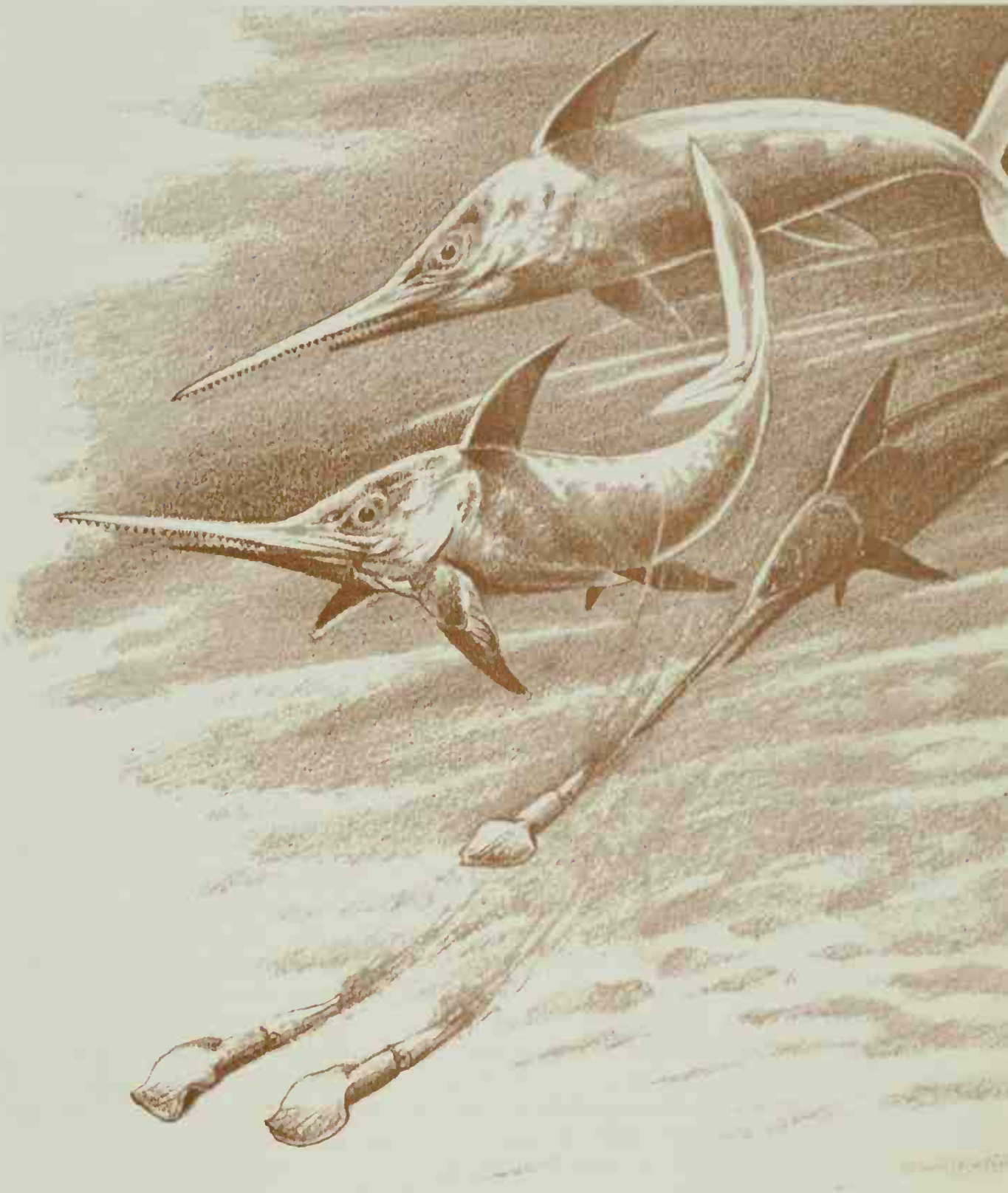




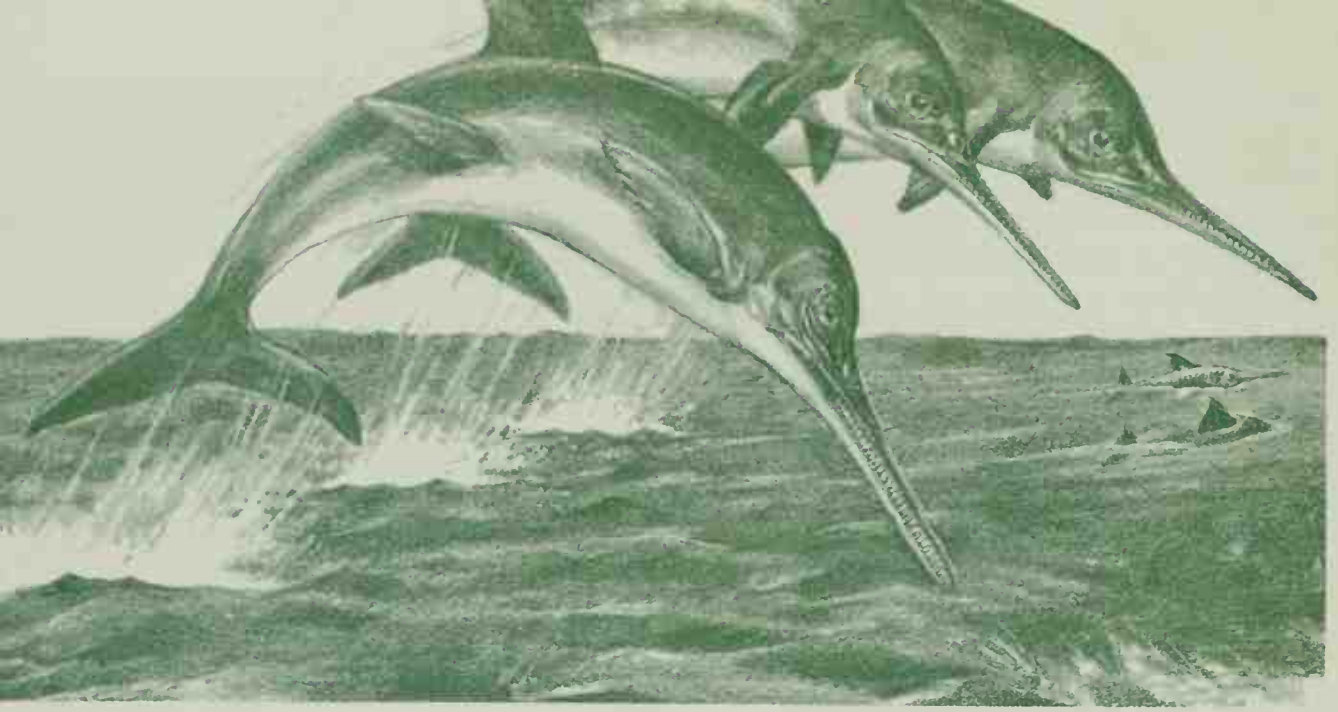
Cymbospondylus

just a guess, for it is obvious that they were good enough at flying to last many millions of years while the dinosaurs ruled on the ground.

Pterosaurs were more like bats than they were like birds — at least in one way. Instead of a wing made of feathers, the pterosaur wing was a thin membrane of skin stretched between the long fingers of the "hand" and the sides of the body and the legs. This is very similar to the bat's wing. One of the most remarkable pterosaurs ever discovered shows very clearly the impression of this wing membrane preserved in the rock right along with the skeleton. This skeleton belongs to the type called Rhamphorhynchus and you may see it at the Peabody Museum at Yale University in Connecticut. The most amazing thing about the pterosaur wing, when it is compared with that of bats or birds, is the way that the membrane was supported. One finger on each "hand" grew to an unbelievable length. Surprising as it may seem, this wing finger in most pterosaurs was longer than the whole arm and in a few cases it was two or three times as long as the arm. So the pterosaur wing span was achieved by having very long fingers, rather than by long arms. Pterosaurs were strange creatures indeed, but they seem to have been the masters of the air during the Jurassic and Cretaceous periods.



Eurhinosaurus



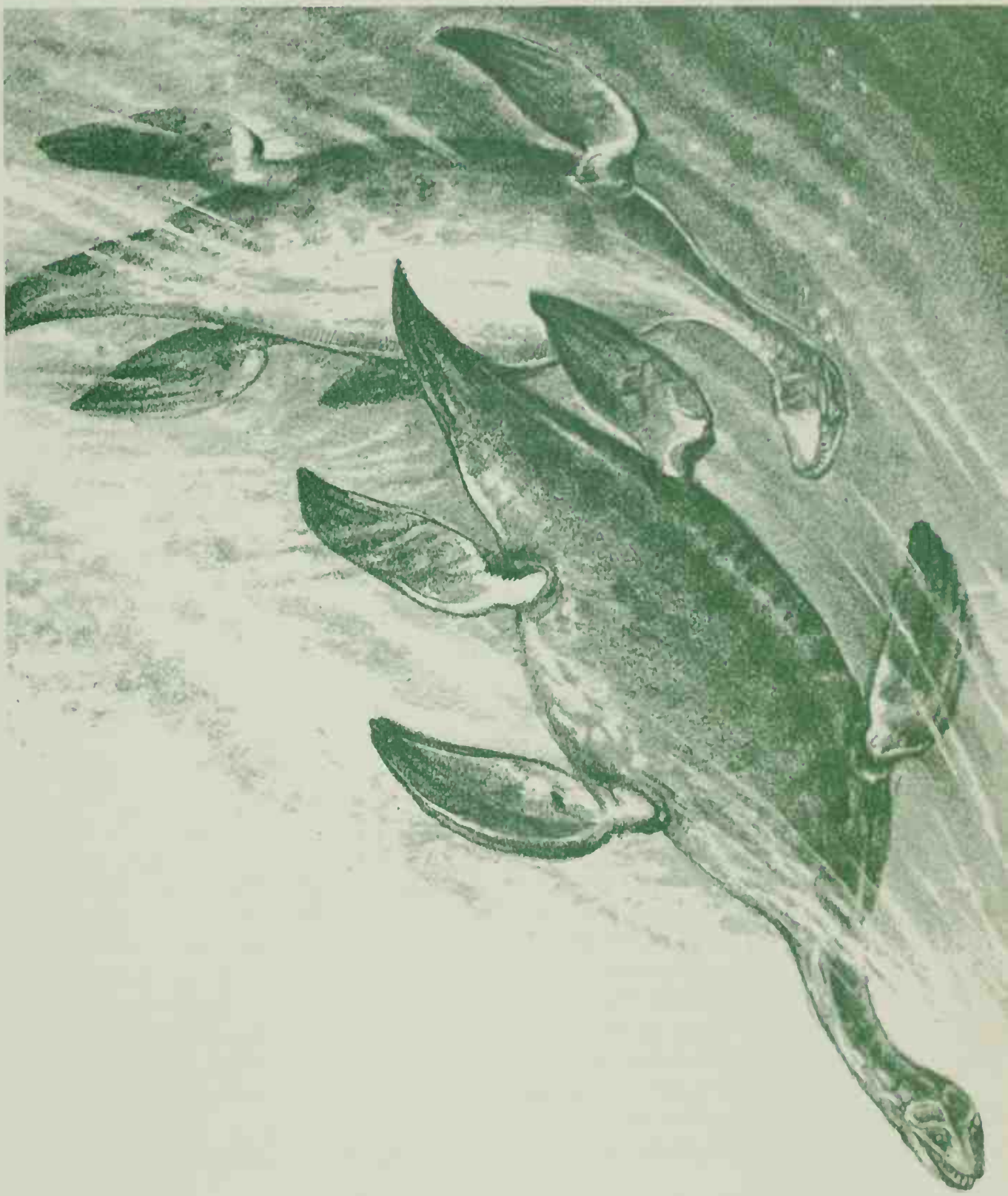
Ichthyosaurus

The swimming reptiles

Just as the air was the property of the pterosaurs, the sea belonged to other reptiles that are now long since extinct. The sea was the home of the ichthyosaurs (IK-thee-o-sawrs), the plesiosaurs (PLEEZ-ee-o-sawrs) and the mosasaurs (MOZE-a-sawrs). These reptiles might be called the "terrible lizards" of the sea, just as the dinosaurs were the "terrible lizards" on the land.

The ichthyosaurs or "fish-lizards" were the most interesting of these sea monsters. They really looked more like large fish than the reptiles that they were. In fact, they were very similar in their outward appearance to the sharks and porpoises of today's seas. Most of the ichthyosaurs were only ten to fifteen feet long, but a few giants over forty feet in length have been discovered. Some giants like this were recently discovered by paleontologists from the University of California in a remote area in Nevada. Ichthyosaurus (IK-thee-o-sawr-us) and Stenopterygius (sten-op-tair-I-jee-us) were widespread in the Jurassic seas around Europe and South America. Eurhinosaurus (your-RINE-o-sawr-us) was also very common around Europe. In North America, the ichthyosaurs most often found are Cymbospondylus (sim-bo-SPON-dee-lus) of Triassic age and Ophthalmosaurus (off-THAL-mo-sawr-us) of Jurassic age. Let us look at this last one a little closer to see what ichthyosaurs were really like.

How much Ophthalmosaurus looks like a fish! Look at that streamlined, fishlike body. And see the fishlike tail and the big dorsal fin on its back. Notice those large paddlelike fins. Could anyone mistake this creature for a land animal? Certainly Ophthalmosaurus was as good at swimming as any fish. Actually, there are some clues that tell us that it was a better swimmer than some of the fish that lived with it. First



Cryptocleidus

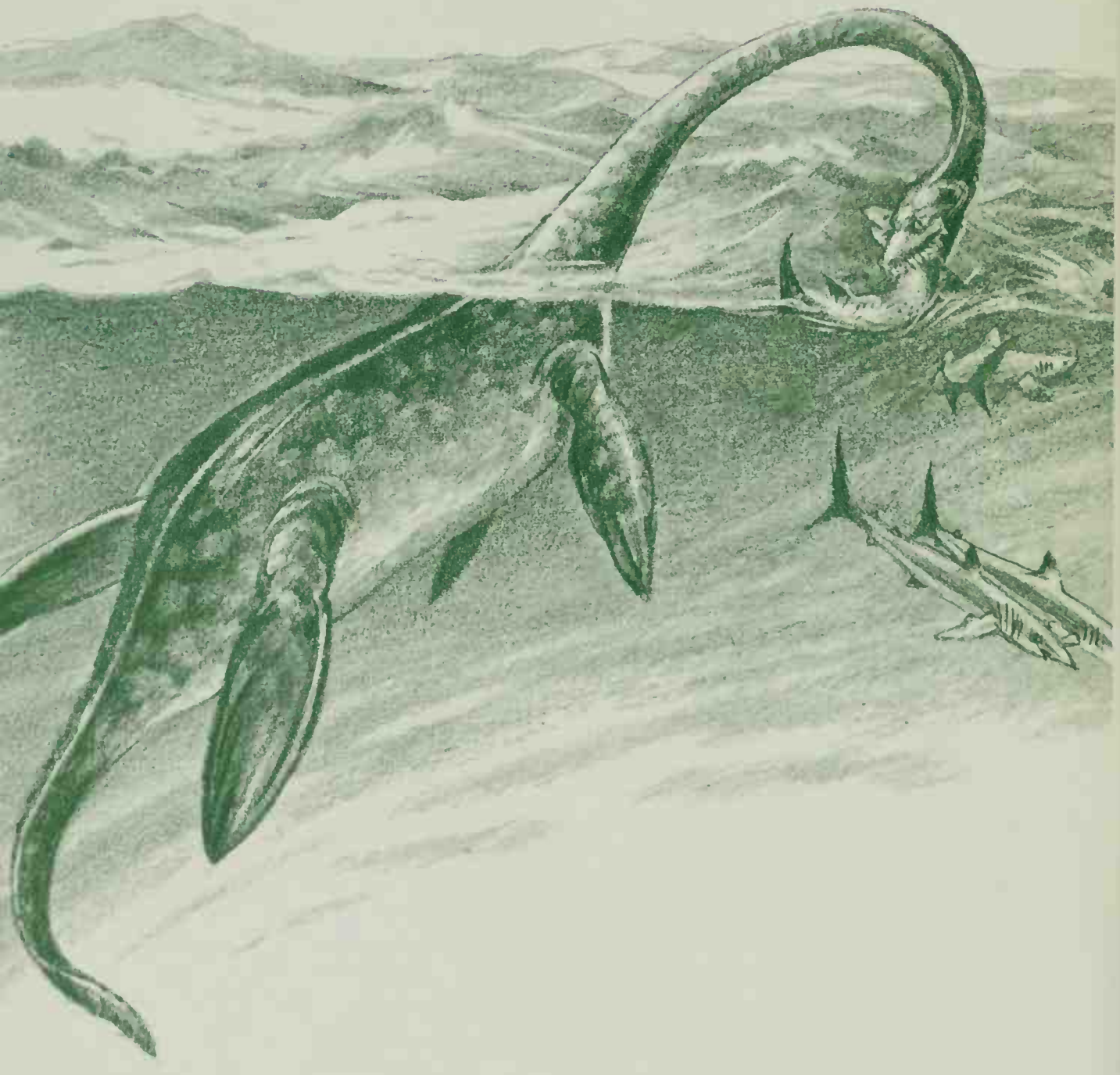
Top, Elasmosaurus. *Bottom,* Clidastes.

of all, notice those enormous eyes. It was those huge eyes that suggested the name Ophthalmosaurus, which means "eye lizard." How keen those eyes must have been for spotting fish! And that long pointed snout with the long mouth full of sharp teeth certainly must have been for catching fish. We suspect that there were many fish of the Jurassic seas that had little chance to escape from fish eaters like Ophthalmosaurus.

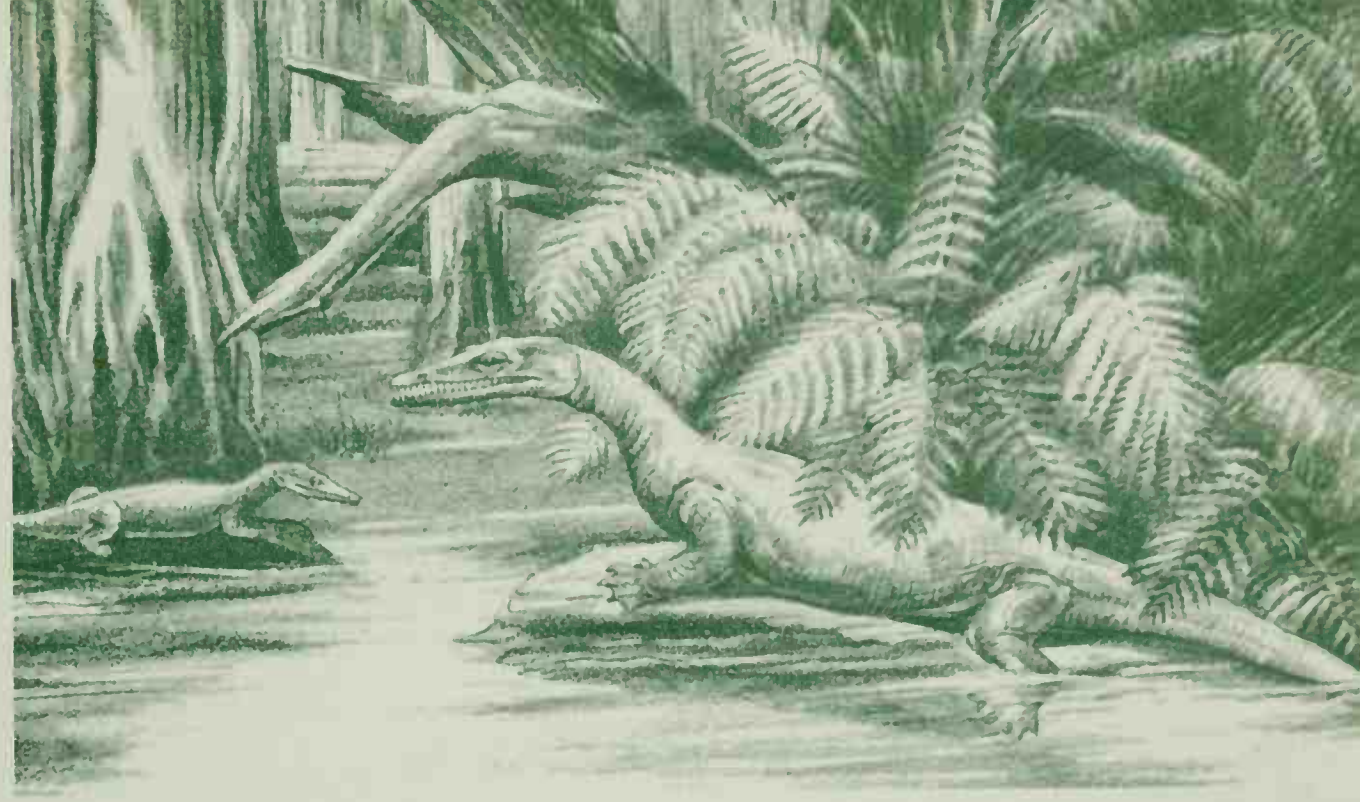
The swimming reptiles, like the ichthyosaurs and mosasaurs, raise an interesting question about how they had their young. We know that most reptiles lay eggs, but what about these water reptiles? They could not climb out of the water to lay their eggs on land. And it doesn't seem likely that they laid them in the water. Then how did they have their young? Fortunately some exciting discoveries have been made that give us the answer to this question — at least for the ichthyosaurs. Full-grown skeletons of ichthyosaurs have been found that have the skeletons of little baby ichthyosaurs inside of them. One skeleton in particular, that can be seen at the American Museum in New York, shows the small skeletons of seven babies inside the skeleton of the mother. This tells us that the ichthyosaurs solved the problem by having their young born alive. Ichthyosaur eggs were kept in the body cavity and hatched there. We still don't know about the plesiosaurs or mosasaurs, but since they could not get out on the land either, we may suppose that they too had their young alive in a similar manner.

Ichthyosaurs were not the only aquatic reptiles that fed on fish. The mosasaurs were the giant fish eaters of the Cretaceous seas. Some of these reptiles grew to be

Top, Tylosaurus. *Bottom*, Trinacromerum.



Plesiosaurus



Nothosaurus

more than twenty feet in length. Clidastes (kly-DASS-teez) and Tylosaurus (TILE-o-sawr-us) are two of the best known mosasaurs from North America. Like the ichthyosaurs, these giant sea reptiles were well designed for pursuing and feeding on fish. The huge jaws with sharp, knifelike teeth must have been the dread of all who got near them. Although fishlike in appearance, the mosasaurs actually are very closely related to the modern lizard called Varanus (var-AN-us). As a matter of fact, the skull of Tylosaurus is just an enlarged version of the skull of Varanus. But the mosasaurs evolved in very different ways than did all the other lizards, for they went back to the water and became fishlike, seagoing lizards.

Sailors of the old clipper ships and sailing vessels are famous for their tales of sea monsters. As a matter of record, there are a few modern sailors who tell of seeing strange monsters of the deep. Even today we hear about sightings of the famous Loch Ness monster of Scotland. Is it possible that such monsters still exist? We wonder, for descriptions of these legendary creatures sound very much like some of the plesiosaurs of the past. It is not possible that a few of the plesiosaurs have survived to the present? Scientists don't think so. It is more likely that these modern "monsters" are mostly imagination. But the plesiosaurs were not imaginary back in the days of the dinosaurs. In fact, plesiosaurs like Nothosaurus (NO-tho-sawr-us), Cryptocleidus (krip-toe-KLIDE-us), Plesiosaurus (PLEEZ-ee-o-sawr-us), Elasmosaurus (ee-LAZ-

Mesosaurus (at bottom)

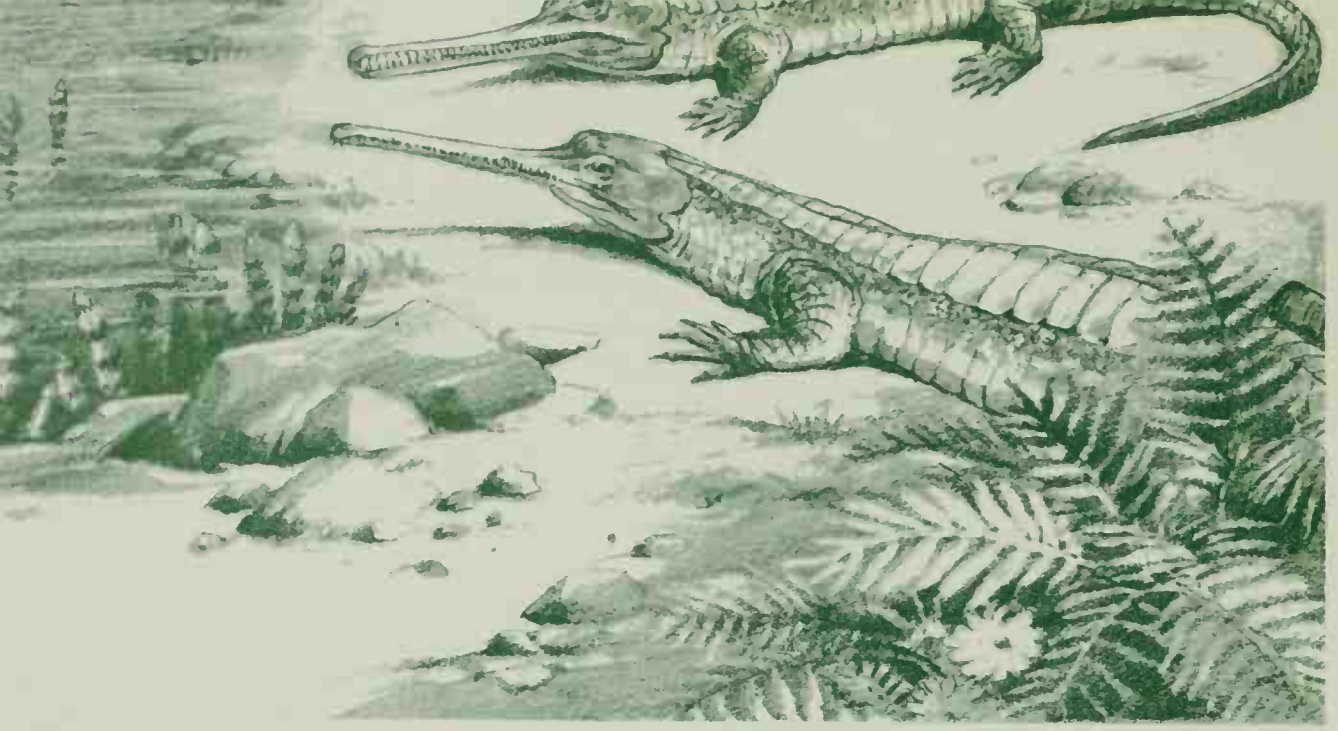
mo-sawr-us) and Trinacromerum (tri-nak-roe-MAIR-um) were quite common in the oceans of those days.

Unlike the ichthyosaurs and mosasaurs, the plesiosaurs were not fishlike at all. They were not at all like any other animal. In some ways they remind us of a giant turtle without its shell. But instead of small flippers like those of turtles, the plesiosaurs had large, oarlike paddles. And a great long neck reached out snakelike in front of the turtlelike body. At the end of this flexible neck was a medium-sized head of the euryapsid type with a single opening high on the skull behind the eye. And as with most flesh-eating animals, the plesiosaur head seems to be all mouth. Here was a different kind of fish eater, for they were certainly not fast swimmers, as the mosasaurs and ichthyosaurs were. But we can imagine them twisting that long neck about through the water and the head darting out after a passing fish.

A close relative of the plesiosaurs was another aquatic animal called Placodus (PLAK-o-dus). This reptile was not a fish eater. Instead, this swimmer moved along close to the bottom in search of clams and other small shellfish. Placodus did not have the long flexible neck or the sharp teeth of the plesiosaurs; instead the neck was quite short and in the mouth were large flat teeth for crushing the shells of clams and other shelled animals.

None of these "sea monsters" ever invaded the fresh waters of lakes and streams, as far as we know, but some swimming reptiles of the past did live in fresh water, rather than in the salt waters of the seas. These were small animals called mesosaurs (MEZ-o-sawrs). Not much is known about the mesosaurs because they are not very commonly found. Mesosaurus (MEZ-o-sawr-us), the best known of these little animals, reminds us a little of the much larger seagoing mosasaurs. The mesosaurs,

Placodus



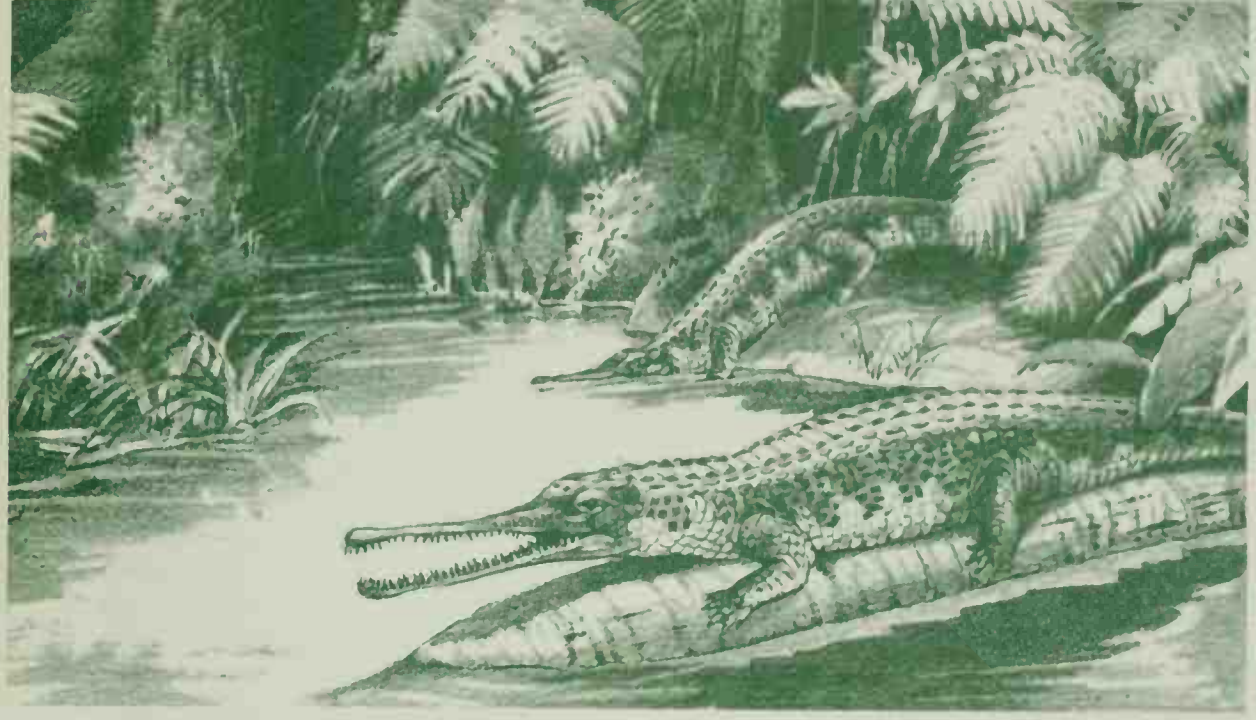
Mystriosuchus

though, were very different. They were often less than two feet long and they never exceeded this length by very much. The skull, which is not well known, seems to be of the synapsid type, rather than of the altered diapsid type that is found in the mosasaurs. The mouth was very long for such small creatures and was full of many very sharp, needlelike teeth. We immediately know from this that the mesosaurs were meat eaters. They may well have fed on small freshwater minnows, or on water insects or other invertebrates. We can't really be sure, but with that mouth full of needles it is certain that they pursued lively food.

Amphibious reptiles

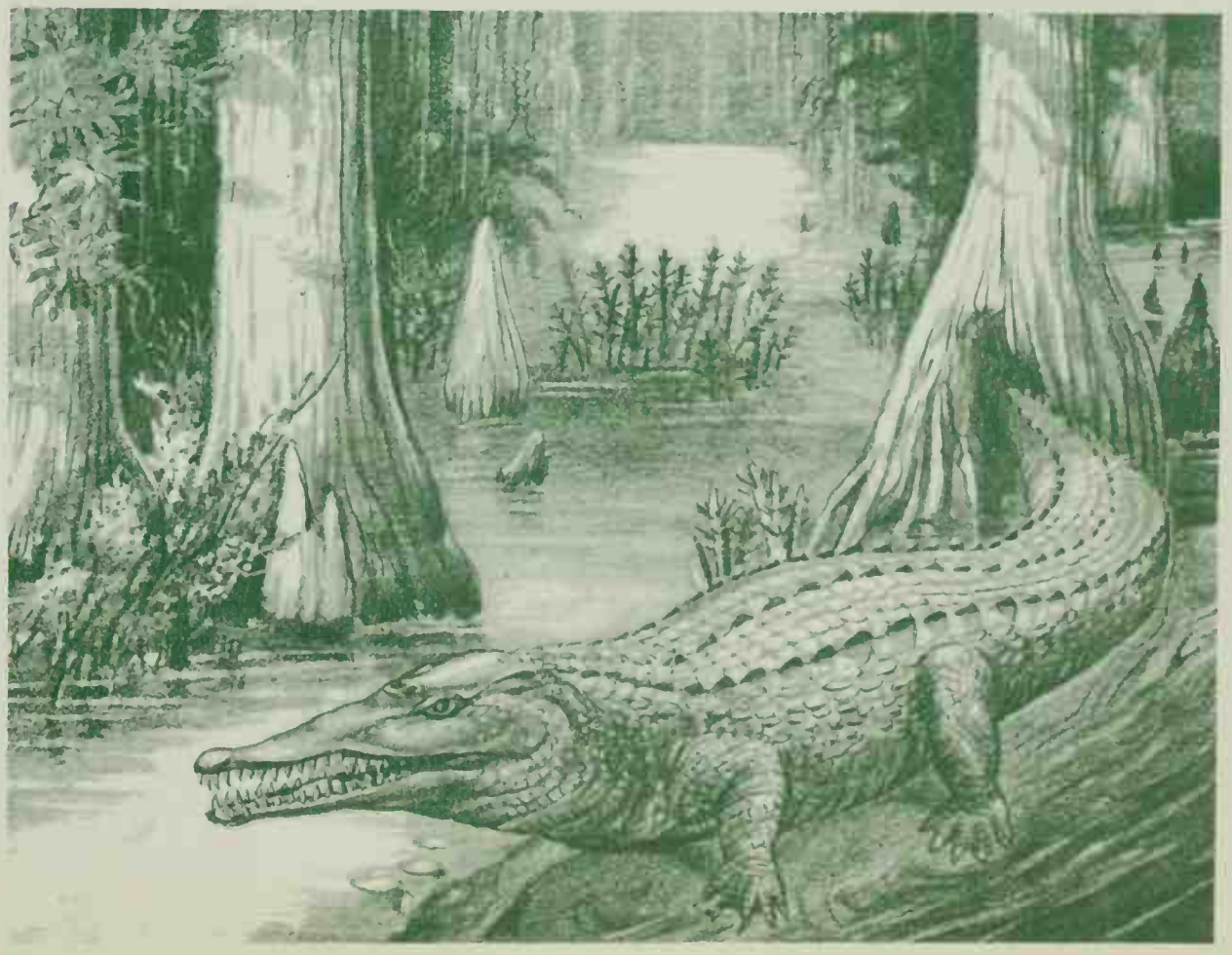
We have seen a number of dinosaurs that are thought to have been amphibious. The duck-billed dinosaurs, like Corythosaurus and the big sauropods such as Diplodocus apparently were happy either in or out of water. Many other reptiles are also known to be amphibious. The crocodiles and alligators are excellent swimmers, as are some turtles. And some snakes and a few lizards are also quite at home in the water. Way back, nearly 200 million years ago, there were other reptiles that loved the water too. These were the phytosaurs that we mentioned earlier.

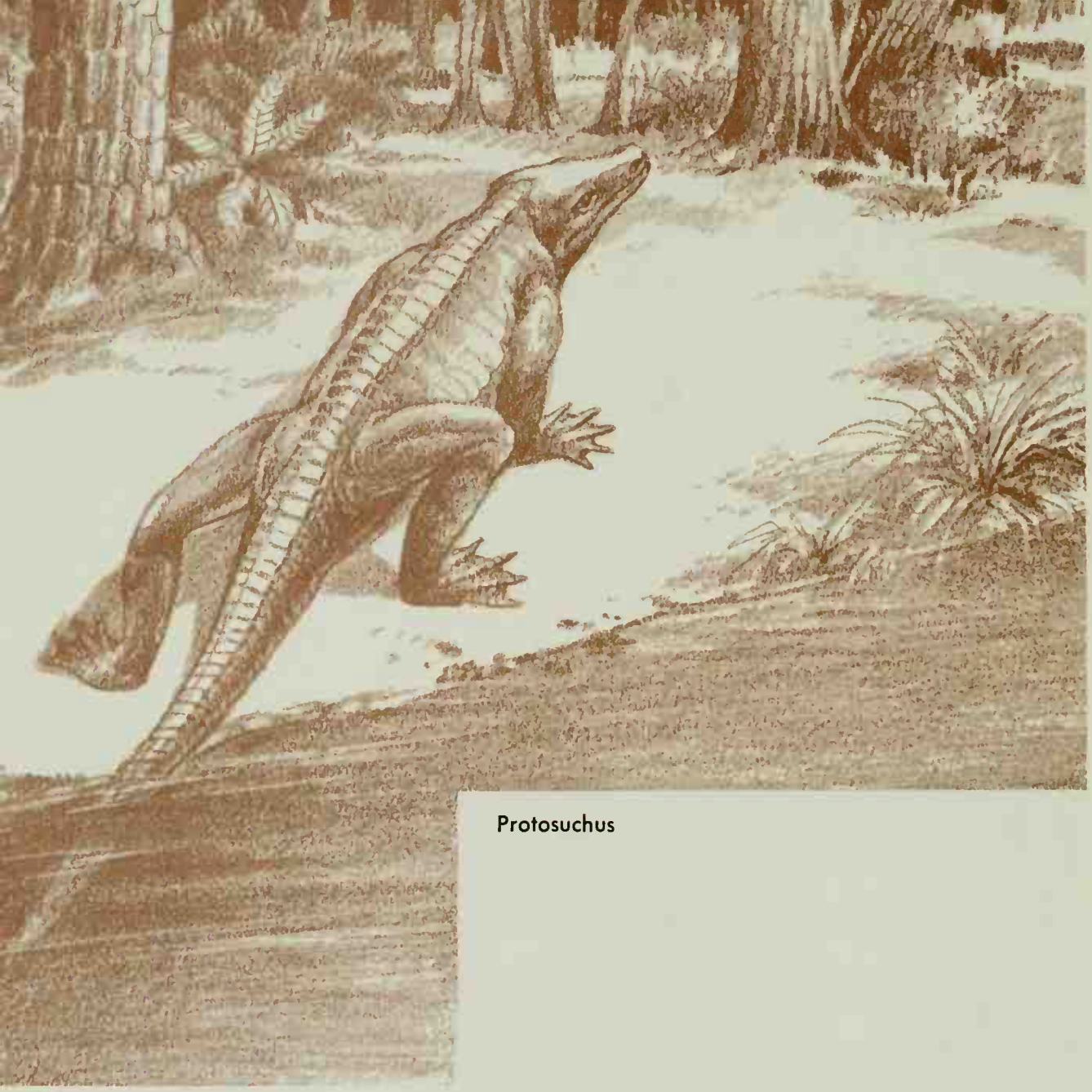
The story of the phytosaurs is a curious one. It is a story that makes us wonder about how nature works. Look at the pictures of Rutiodon (ROOT-ee-o-don) and that of the phytosaur with the long name – Machaeroprosopus (mak-eye-roe-pro-



Rutiodon

Machaeroprosopus





Protosuchus

SOPE-us). Did you call them crocodiles —or alligators? They certainly remind us of our modern crocodiles and alligators and they probably lived very much as these modern reptiles do. As a matter of fact, it is difficult for us to imagine the phytosaurs living in any other way. See how they lie "loglike" along the bank of the river. Then something attracts them, and they slither down the bank into the water — without the slightest splash. The long, flat tail waves back and forth and they swim swiftly out into the river after their victim.

Certainly the phytosaurs must have been closely related to the crocodiles and alligators of today. But scientists tell us that they were not. Phytosaurs only looked like crocodiles and actually they were only very distantly related to them. They really

Champsosaurus

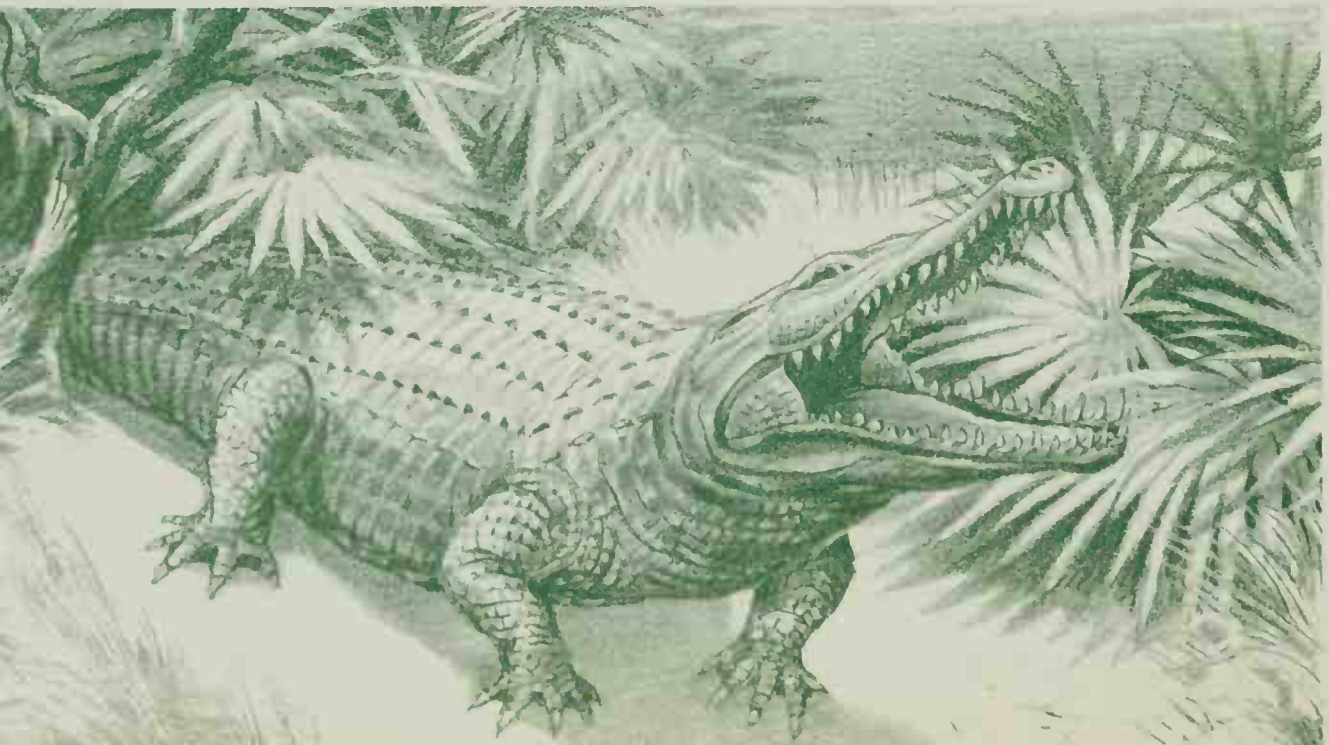
were thecodonts and were closely related to the ancestors of the dinosaurs. Mystriosuchus (miss-tree-o-SOOK-us) and Rutiodon were close relatives of the land animals Ornithosuchus and Saltoposuchus that we saw earlier.

The strange thing about the phytosaur story is that even though they looked very much like crocodiles, and probably lived like crocodiles, they became extinct. The crocodiles? — of course they lived on. The phytosaurs lived during the Triassic period, but they all died out before the end of that period. The first of the crocodiles appeared near the end of the Triassic, just before the extinction of the phytosaurs, and by the days of the Jurassic period crocodiles were very common animals and they have been important ever since. Why should the crocodiles have been able to live on when the phytosaurs could not? These animals seem so much alike that we can't imagine why the phytosaurs were unable to live on. But since these animals lived at different times, we can suppose that the phytosaurs were faced with some conditions that the later crocodiles never encountered. We may never know the answer, but we can see that this kind of life has been very successful since the beginning of the Triassic period, for even the phytosaurs lived for millions of years before they disappeared. There are advantages in being able to live either in the water or on land.

Turning from the phytosaurs to the crocodiles for a minute, let's look at some animals of the past that may surprise you. We all know what crocodiles look like, so how can fossil crocodiles be very interesting? In some ways you are right; most fossil crocodiles look exactly like what they are — crocodiles. Even little Protosuchus (protoe-SOOK-us), only two or three feet long, looks like a crocodile of today. Protosuchus is a very important fossil to paleontologists, for this little creature from the

Left, Dicynodon. *Right*, Kannemeyeria.

Phobosuchus



Moschops

late Triassic rocks of Arizona is the very first of the crocodile family – nearly 200 million years old. Just imagine, the crocodiles have roamed through the earth's swamps and rivers for almost 200 million years – since the time of the first dinosaurs!

But not all fossil crocodiles are what we expect. Look at Phobosuchus (fobe-o-SOOK-us). Here was a giant that dwarfed even many of the dinosaurs that lived along with him. Alligators of today may grow to twelve or fifteen or, rarely, even twenty feet in length, but Phobosuchus was more than fifty feet long. Can you imagine a crocodile longer than many whales? This was truly a monster. Phobosuchus was discovered in a Cretaceous sandstone in Texas – just as we might have guessed. Texans have always said everything is bigger in Texas.

Another unexpected crocodile of the past is the much smaller Geosaurus (JEE-o-sawr-us). This little crocodile had completely given up life on the land and became a full-time swimmer. Very likely, it was not at all amphibious, as were the other crocodiles. As you can see, it looked much more like a fish than a crocodile (page 123).

The mammal-like reptiles

Earlier, we learned about the fin-backed reptiles called pelycosaurs that lived during the Permian period. You will remember that these animals had a special type of skull with a single opening in back of the eye. This was called a synapsid skull. Although the pelycosaurs became extinct before the beginning of the Triassic period, they had some descendants with the same kind of skull structure. These

were the therapsid (thair-AP-sid) reptiles. They are often called the mammal-like reptiles, because many of them looked more like mammals than like reptiles. And some of these therapsids are now thought to be the ancestors of the mammals.

Scientists still classify these animals as reptiles, for they have many reptilian features. But we cannot be sure that they had scales rather than hair, or that they laid eggs instead of having their young born alive as mammals do. And of course we have no way to tell whether they were warm-blooded or cold-blooded. We can only guess about this, but we still have the skeletons, and in most features these are the skeletons of reptiles.

The therapsids were very common animals during the Permian and Triassic periods. In Africa and Asia and Europe there were many different kinds. Some therapsids are also known from South America. But it was just a few years ago in 1954 that the first good therapsid skeletons were discovered in North America in Monument Valley of northern Arizona. This was a very exciting discovery, of course, and it was a very important one as well. For it showed that the therapsids, like the dinosaurs, lived all over the world. And all together, there may have been as many kinds of therapsids as there were dinosaurs. Perhaps more.

In the therapsids, we see another story very much like that of the dinosaurs. There were many plant-eating therapsids, and of course there were meat eaters as well. Just a few of these mammal-like reptiles are pictured here to show you what

Cynognathus

Lycaenops

strange beasts the therapsids were, because it would take another whole book to tell you the therapsid story. Many of the plant-eating therapsids were rather large, heavy and clumsy-looking animals such as those you see here: Dicynodon (die-SINE-o-don), Kannemeyeria (kan-nee-may-AIR-ee-ya), and Moschops (MOSS-kops). The flesh eaters, on the other hand, like Cynognathus (sine-o-NAY-thus) and Lycaenops (lie-SINE-ops), were more lightly built and not at all clumsy-looking. This is what we might expect. If a meat eater is going to eat, it cannot afford to be clumsy, but must be quick enough to catch its meal.

Just as with the dinosaurs, there were therapsids of all sizes and shapes and they followed many different ways of life on all the continents of the world. But this story must wait for another time and another book.

7

The End of the Dinosaurs

After traveling back through time to look at all the strange reptiles of the past, the reptiles of today look rather tame and unexciting. But a close look at a hungry alligator or an angry crocodile shows us that they can be rather exciting. We can see that there is a little bit of the dinosaur world left. Turtles and lizards and snakes seem to be pretty quiet, harmless animals. Turtles go quietly about their business and don't seem to bother anyone. Lizards seem to spend all of their time basking in the sun, or dashing out of sight among the rocks. And even the snakes are slow, sleepy creatures. These are small reptiles — much smaller than most of the dinosaurs — and they don't attract our attention easily. If we could shrink ourselves down to their size, though, and watch the way they live, we would see that they too are exciting. Here too we find both meat eaters and plant eaters. And in their own smaller way they have the same battles for food and life. Perhaps the fact that they were smaller than their extinct dinosaurian relatives made it easier for them. They can hide more easily and they need less food. Perhaps this is why they lived on after the dinosaurs became extinct.

Everyone knows that the dinosaurs became extinct about 75 million years ago. But no one really knows why. Many ideas have been suggested and perhaps you have some ideas of your own. One puzzling thing about this mystery is why animals like crocodiles, alligators, lizards, snakes and turtles did not become extinct too. These animals were all living during the days of the dinosaurs, but they all escaped whatever it was that killed off the dinosaurs. To understand the problem of extinction, we should remember that many other reptiles died out along with the dinosaurs. For example, all of the ichthyosaurs, plesiosaurs, and mosasaurs also died out. The end of the Cretaceous period was a time that saw many reptiles disappear. Why? How did they die out? Why did the few modern reptiles survive?

Some people think that the plant food died out first, so that the plant-eating dinosaurs starved. This meant that the meat eaters also starved when the last of the plant

eaters was gone. This is possible, for we know that toward the end of the dinosaur age, many new kinds of plants and trees appeared. The plant-eating dinosaurs may not have been able to eat these new plants. But many of the new plant types appeared long before the dinosaurs died out — millions of years before. Some of the dinosaurs, at least, seem to have been able to eat the new plants, or else they survived by eating the few remaining old plant types. But how would these land plants affect all of the sea reptiles? Remember, they became extinct too.

It may have been a severe change in the climate that killed off all these reptiles. The temperature could have gotten much colder or much warmer. If it became too hot, the large dinosaurs might not have been able to hide in the shade. And since they were not able to control their temperature as mammals are, this might have caused their extinction. But could this have killed off the mosasaurs and ichthyosaurs that lived in the sheltered waters of the oceans? What about a severe drop in temperature? This might have killed off the dinosaurs, but how did the small lizards and snakes and turtles survive such cold weather? They would have been even more severely affected by cold climate than the larger dinosaurs. Also, what about the sea reptiles? It would have to get very cold to affect them.

Another idea is that small animals, perhaps the mammals, ate all of the dinosaur eggs. This too is a possibility, but they were not able to eat the eggs of the sea reptiles. Many ideas pop into our heads now. It might have been diseases that wiped out these reptiles. Or it might have been a long dry spell. But, as we think of all the reasons that might explain dinosaur extinction, we begin to see that one simple answer is not enough. The dinosaurs did not all live in the same place and they did not all die out at the same time. And as we have seen, there were many different kinds living different kinds of lives. With these thoughts in mind, we can see that there must be more than one answer to this question.

The world is a changing place. It is never the same from one minute to the next. So about all we can say now is that the world of the dinosaurs changed and it must have changed in many ways — not just in one way. We already know that the kinds of plants changed during the reign of the dinosaurs. And we have seen how the animals themselves changed or evolved through time. And with the passing of the years, there must have been changes in the climate. All of these changes, and others that we don't know about, made the world a different place. And we must conclude that the world was no longer a fit place for the dinosaurs — or the mosasaurs — or the plesiosaurs — or the ichthyosaurs. We see that many animal kinds died out while a few reptile types lived on. This does not tell us the real reason that the dinosaurs became extinct, but it helps us to understand a little better how it all happened — and how it could happen again. The dinosaurs, like many animals before them — and many others after them — just were not able to keep up with their changing world. This was the end of the dinosaurs — and this is the end of our story about the strange world of the dinosaurs. But remember, the dinosaurs are only a chapter in the much longer story of life in the past.

Geosaurus

8

The Continuing Search

ALTHOUGH WE have come to the end of the strange world of the dinosaurs, a further word is in order — just to be sure you realize that more is being added to this story every day. A favorite question asked of paleontologists is: Are there any more dinosaurs to be discovered? Have all the dinosaurs been found? The answer is: Of course there are many more dinosaurs still to be discovered. Many discoveries will be of dinosaurs already known to scientists, but some will be brand-new. Some will add greatly to our knowledge, as the recent discoveries of Coelophysis did. Scientists are still looking for dinosaur bones and the fossils of other ancient animals in Europe, in Asia, in Africa, and in all the lands around the world. Expeditions go out every year to some far corner of the earth and discoveries are made. Tsintaosaurus was found only a few years ago in China. A new armored dinosaur was found in Kansas in 1956, and just a few years before, a new duck-billed dinosaur was found in Alabama. And as recently as 1962, new dinosaurs were discovered in South Africa. There are probably many more dinosaurs that we don't know about yet, but finding and collecting dinosaurs costs a great deal of money. It takes time to track down and "catch" a dinosaur. But the search goes on and paleontologists still walk the hills looking for these ancient animals. And you can be sure that the search will continue and discoveries will be made as long as people have curiosity about animals of the past.

Classification of Vertebrate Animals

Class Pisces (fish)
Class Amphibia (frogs, toads, salamanders)
Class Reptilia
  Order Cotylosauria (ancient and primitive, anapsid reptiles)
    Diadectes, Hypsognathus, Labidosaurus, Seymouria
  Order Chelonia (turtles)
  Order Pelycosauria (primitive synapsid, mammal-like reptiles – the fin-back reptiles)
    Cotylorhynchus, Dimetrodon, Edaphosaurus, Ophiacodon, Sphenacodon, Varanosaurus
  Order Therapsida (advanced mammal-like reptiles)
    Cynognathus, Dicynodon, Kannemeyeria, Lycaenops, Moschops
  Order Protorosauria (ancient, lizardlike reptiles)
    Araeoscelis, Tanystropheus
  Order Mesosauria (small, freshwater, swimming reptiles)
    Mesosaurus
  Order Sauropterygia (plesiosaurs)
    Cryptocleidus, Elasmosaurus, Nothosaurus, Placodus, Plesiosaurus, Trinacromerum
  Order Ichthyosauria (ichthyosaurs)
    Cymbospondylus, Eurhinosaurus, Ichthyosaurus, Ophthalmosaurus, Stenopterygius
  Order Thecodontia (phytosaurs and dinosaur ancestors)
    Suborder Phytosauria (phytosaurs)
      Machaeroprosopus, Mystriosuchus, Rutiodon
    Suborder Pseudosuchia (dinosaur ancestors)
      Desmatosuchus, Ornithosuchus, Saltoposuchus, Scleromochlus
  Order Saurischia (lizard-hipped dinosaurs)
    Suborder Theropoda (flesh-eating dinosaurs)
      Acrocanthosaurus, Antrodemus (Allosaurus), Ceratosaurus, Coelophysis, Coelurus (Ornitholestes), Compsognathus, Gorgosaurus, Megalosaurus, Ornithomimus (Struthiomimus), Oviraptor, Podokesaurus, Procompsognathus, Saltopus, Tyrannosaurus
    Suborder Sauropoda (brontosaur-like dinosaurs)
      Apatosaurus (Brontosaurus), Brachiosaurus, Camarasaurus, Cetiosaurus, Diplodocus, Plateosaurus, Titanosaurus, Yaleosaurus
  Order Ornithischia (bird-hipped dinosaurs)
    Suborder Ornithopoda (bipedal, plant-eating dinosaurs)
      Anatosaurus (Trachodon), Brachylophosaurus, Camptosaurus, Cheneosaurus, Corythosaurus, Edmontosaurus, Hypacrosaurus, Hypsilophodon, Iguanodon, Kritosaurus, Lambeosaurus, Pachycephalosaurus, Parasaurolophus, Procheneosaurus, Prosaurolophus, Psittacosaurus, Saurolophus, Stegoceras (Troödon), Thescelosaurus, Tsintaosaurus
    Suborder Stegosauria (plated dinosaurs)
      Scelidosaurus, Stegosaurus

Suborder Ankylosauria (armored dinosaurs)

Acanthopholis, Euoplocephalus (Ankylosaurus), Nodosaurus, Palaeoscincus, Polacanthus, Scolosaurus, Syrmosaurus

Suborder Ceratopsia (horned dinosaurs)

Anchiceratops, Chasmosaurus, Leptoceratops, Monoclonius, Pachyrhinosaurus, Pentaceratops, Protoceratops, Styracosaurus, Torosaurus, Triceratops

Order Pterosauria (flying reptiles)

Dimorphodon, Dorygnathus, Pteranodon, Pterodactylus, Rhamphorhynchus, Scaphognathus

Order Crocodilia (alligators and crocodiles)

Alligator, Crocodilus, Geosaurus, Phobosuchus, Protosuchus

Order Squamata (lizards, snakes and mosasaurs)

Clidastes, Draco, Tylosaurus, Varanus

Class Aves (birds)

Class Mammalia (fur-bearing, warm-blooded vertebrates)

Glossary and Index of Scientific Names

Acanthopholis (a-KANTH-o-fole-iss) – means "prickly scale," 86; illus., 85

Acrocanthosaurus (ak-roe-KANTH-o-sawr-us) – means "high edge," after the high vertebral spines, 42-45; illus., 46

Allosaurus (AL-o-sawr-us) – means "other lizard," 36-42; illus., 44

Amphibia (am-FIB-ee-ya) – means "double life."

Anapsida (an-AP-sid-a) – means "without an arch," referring to no skull openings.

Anatosaurus (an-AT-o-sawr-us) – means "duck lizard," 73-77; illus., 64, 69

Anchiceratops (AN-chi-sair-a-tops) – means "near horn face," 92-93; illus., 90

Ankylosauria (an-KILE-o-sawr-ee-ya) – means "curved lizards."

Ankylosaurus (an-KILE-o-sawr-us) – means "curved lizard," 84-86; illus., 82

Antrodemus (an-troe-DEE-mus) – means "hollow build," referring to the vertebrae, 42, 44, 46, 54, 62, 81, 82; illus., 44

Apatosaurus (a-PAT-o-sawr-us) – means "deceptive lizard," 53; illus., 51

Araeoscelis (air-ee-OSS-eel-iss) – means "thin leg," 30; illus., 31

Aves (AH-vaze) – means "birds."

Brachiosaurus (BRAK-ee-o-sawr-us) – means "arm lizard," 50, 53, 54, 57; illus., 50

Brachylophosaurus (brak-ee-LOFE-o-sawr-us) – means "short-crest lizard," 77; illus., 64, 77

Brontosaurus (BRON-toe-sawr-us) – means "thunder lizard," 14, 44, 50, 52; illus., 51

Camarasaurus (KAM-are-a-sawr-us) – means "chamber lizard," referring to cavities in the vertebrae, 53; illus., 57

Camptosaurus (KAMP-toe-sawr-us) – means "bent lizard," illus., 61, 115

Ceratopsia (sair-a-TOP-see-ya) – means "horn faces."

Ceratosaurus (sair-AT-o-sawr-us) – means "horn lizard," 42, 44-45; illus., 44

Cetiosaurus (SEET-ee-o-sawr-us) – means "monstrous lizard," 53; illus., 56

Chasmosaurus (KAZ-mo-sawr-us) – means "opening lizard," referring to the openings in the neck shield, 92; illus., 89

Chelonia (chel-O-nee-ya) – means "tortoises."

Cheneosaurus (KEEN-ee-o-sawr-us) – means "goose lizard," 70, 74; illus., 64, 67

Clidastes (kly-DASS-teez) – means "key resemblance," 109; illus., 106

Coelophysis (SEE-lo-fise-iss) – means "hollow nature," referring to hollow bones, 36, 37, 38, 42, 44, 123; illus., 39

Coelurus (see-LURE-us) – means "hollow sack," referring to hollow spaces in bones, 39; illus., 42

Compsognathus (komp-so-NAY-thus) – means "elegant jaw," 41; illus., 45

Corythosaurus (kor-ITH-o-sawr-us) – means "helmet lizard," 73, 74, 112; illus., 65, 68

Cotylorhynchus (ko-TIE-lo-rink-us) – means "cup nose," 27-28; illus., 29

Cotylosauria (ko-TIE-lo-sawr-ee-ya) – means "cup lizards."

Crocodilia (krok-o-DIL-ee-ya) — means "crocodiles."
Cryptocleidus (krip-toe-KLIDE-us) — means "hidden key," 109; illus., 105
Cymbospondylus (sim-bo-SPON-dee-lus) — means "hollow vertebrae," 104; illus., 102
Cynognathus (sine-o-NAY-thus) — means "dog jaw," 120; illus., 118

Desmatosuchus (dez-mat-o-SOOK-us) — means "link crocodile," 34; illus., 24
Diadectes (die-a-DEK-teez) — means "cross bite," referring to cross wedge teeth, 23; illus., 25
Diapsida (die-AP-sid-a) — means "two arches," referring to two openings in skull.
Dicynodon (die-SINE-o-don) — means "two dog tooth," 120; illus., 116
Dimetrodon (die-MEET-roe-don) — means "two measure tooth," referring to two sizes of teeth, 26, 27; illus., 26
Dimorphodon (die-MORF-o-don) — means "two form tooth," referring to two tooth shapes, 101; illus., 98
Dinosauria (dine-o-SAWR-ee-ya). Means "terrible lizards."
Diplodocus (di-PLOD-oke-us) —means "double beam," referring to backbone, 50, 53, 67, 112; illus., 52
Dorygnathus (dor-ee-NAY-thus) — means "spear jaw," 101; illus., 100
Draco (DRAY-ko) — means "dragon."

Edaphosaurus (ee-DAF-o-sawr-us) — means "base lizard," 26, 27, 28; illus., 29
Edmontosaurus (ed-MON-toe-sawr-us) — means "Edmonton lizard," referring to Edmonton, Canada, a town near where this animal is found, 70, 77; illus., 62, 64
Elasmosaurus (ee-LAZ-mo-sawr-us) — means "thin-plate lizard," 109; illus., 106
Euoplocephalus (you-o-plo-SEF-a-lus) — means "well-armed head," 84; illus., 82
Euryapsida (your-ee-AP-sid-a) — means "broad arch," referring to a single opening in the skull.
Eurhinosaurus (your-RINE-o-sawr-us) — means "broad-nose lizard," 104; illus., 103

Geosaurus (JEE-o-sawr-us) — means "earth lizard," 117; illus., 123
Gorgosaurus (GORE-go-sawr-us) — means "terrible lizard," 42, 45, 46, 54, 74, 84; illus., 47

Hadrosaur (HAD-roe-sawr) — means "bulky lizard."
Hypacrosaurus (hi-PAK-roe-sawr-us) — means "high-peak lizard," referring to the high spines on the vertebrae, 74; illus., 65, 73
Hypsilophodon (hip-si-LOFE-o-don) — means "high-crested tooth," illus., 63
Hypsognathus (hip-so-NAY-thus) — means "high jaw," 25; illus., 27

Ichthyosauria (ik-thee-o-SAWR-ee-ya) — means "fish lizards."
Ichthyosaurus (IK-thee-o-sawr-us) — means "fish lizard," 104; illus., 104
Iguanodon (ig-WAN-o-don) — means "iguana tooth," referring to the modern lizard called Iguana, 35, 61, 62; illus., 58

Kannemeyeria (kan-nee-may-AIR-ee-ya) — means "Meyer's dog," 120; illus., 116
Kritosaurus (KRITE-o-sawr-us) — means "chosen lizard," 77; illus., 64, 74

Labidosaurus (lab-ID-o-sawr-us) — means "tong lizard," referring to the tonglike jaws, 23, 28; illus., 24
Lambeosaurus (LAM-bee-o-sawr-us) — means "Lambe's lizard," referring to Lawrence Lambe, the man who discovered this animal, 74; illus., 65, 72
Leptoceratops (LEP-toe-sair-a-tops)—means "small horn face," 93; illus., 93
Lycaenops (lie-SINE-ops) — means "wolf face," 120; illus., 119

Machaeroprosopus (mak-eye-roe-pro-SOPE-us) — means "knife border," referring to the sharp crest on the snout, 112; illus., 113
Mammalia (mam-AY-lee-ya) — means "breasted animals."
Megalosaurus (MEG-a-lo-sawr-us) — means "great lizard," 35, 42, 45; illus., 48
Mesosauria (mez-o-SAWR-ee-ya) — means "middle lizards."
Mesosaurus (MEZ-o-sawr-us) — means "middle lizard," 111; illus., 110
Monoclonius (mon-o-KLONE-ee-us) — means "single stem," referring to the single horn on the skull, 87, 89, 92; illus., 88
Mosasauria (moze-a-SAWR-ee-ya)—means "Meuse River lizards," referring to the locality where mosasaurs were first found.
Moschops (MOSS-kops) — means "calf face," 120; illus., 117
Mystriosuchus (miss-tree-o-SOOK-us) — means "spoon crocodile," 115; illus., 112

Nodosaurus (NO-doe-sawr-us) — means "toothless lizard," 84, 86; illus., 87, 109
Nothosaurus (NO-tho-sawr-us) — means "spurious lizard," 109; illus., 109

Ophiacodon (o-fee-AK-o-don) — means "snake tooth," 27, 28; illus., 28
Ophthalmosaurus (off-THAL-mo-sawr-us)—means "eye lizard," 104; illus., 101
Ornithischia (or-nith-ISS-kee-ya) — means "bird hip."
Ornitholestes (or-nith-o-LESS-teez) — means "bird robber."

Ornithomimus (or-nith-o-MIME-us) — means "bird imitator," 39, 40; illus., 43, 47
Ornithopoda (or-ni-THOP-ode-a) — means "bird foot."
Ornithosuchus (or-nith-o-SOOK-us) — means "bird crocodile," 33, 50, 115; illus., 31
Oviraptor (o-vee-RAP-tor) — means "egg stealer," 40; illus., 40

Pachycephalosaurus (pak-ee-SEF-a-lo-sawr-us) — means "thick head," 77; illus., 76
Pachyrhinosaurus (pak-ee-RINE-o-sawr-us) — means "thick-nose lizard." One of the armored dinosaurs, 93; illus., 91
Palaeoscincus (pale-ee-o-SKINK-us) — means "ancient lizard," 84, 86; illus., 82
Parapsida (pair-AP-sid-a) — means "beside arch," referring to the single opening in the skull behind the eye.
Parasaurolophus (pair-a-sawr-OL-o-fus) — means "close to lizard crest," referring to another dinosaur Saurolophus, 75; illus., 65, 74
Pelycosauria (pel-i-ko-SAWR-ee-ya) — means "basin lizards."
Pentaceratops (PEN-ta-sair-a-tops) — means "five horn face," 92, 93; illus., 91
Phobosuchus (fobe-o-SOOK-us) — means "fear crocodile," 117; illus., 116
Phytosauria (fite-o-SAWR-ee-ya) — means "plant lizard," because they were first thought to be plant eaters.
Pisces (PIS-kes) — means "fish."
Placodus (PLAK-o-dus) — means "plate tooth," 111; illus., 111
Plateosaurus (PLATE-ee-o-sawr-us) — means "flat lizard," 50, 52; illus., 53
Plesiosaurus (PLEEZ-ee-o-sawr-us) — means "near lizard," 109; illus., 108
Podokesaurus (po-DOKE-ee-sawr-us) — means "swift-footed lizard," 38; illus., 38
Polacanthus (pole-a-KAN-thus) — means "rod edge," referring to the body spines, 84, 86; illus., 83
Procheneosaurus (pro-KEEN-ee-o-sawr-us) — means "first goose lizard," 70, 74; illus., 64, 66
Procompsognathus (pro-komp-so-NAY-thus) — means "first elegant jaw," 38, 41; illus., 41
Prosaurolophus (pro-sawr-OL-o-fus) — means "first lizard crest," 74, 77; illus., 65, 71
Prosauropoda (pro-sawr-o-PODE-a) — means "first lizard foot."
Protoceratops (pro-toe-SAIR-a-tops) — means "first horn face," 41, 87, 89, 93; illus., 40, 86
Protorosauria (pro-tor-o-SAWR-ee-ya) — means "first lizards."
Protosuchus (pro-toe-SOOK-us) — means "first crocodile," 115; illus., 114
Pseudosuchia (soo-doe-SOOK-ee-ya) — means "false crocodile."
Psittacosaurus (sit-a-ko-SAWR-us) — means "parrot lizard," 78, 86, 87; illus., 78
Pteranodon (tair-AN-o-don) — means "wing without tooth," referring to the toothless jaws, 101; illus., 99
Pterodactylus (tair-o-DAK-tee-lus) — means "wing finger," 101; illus., 97
Pterosauria (tair-o-SAWR-ee-ya) — means "wing lizard," illus., 96

Reptilia (rep-TIL-ee-ya) — means "creeping animals."
Rhamphorhynchus (ram-for-RINK-us) — means "knife beak," 101; illus., 98
Rutiodon (ROOT-ee-o-don) — means "plant tooth," referring to the original idea that these were plant eaters, 112, 115; illus., 113

Saltoposuchus (salt-o-po-SOOK-us) — may mean "leaping crocodile," but original meaning not known for certain, 33, 50, 52; illus., 32
Saltopus (SALT-o-pus) — means "leaping foot," 38; illus., 41
Saurischia (sawr-ISS-kee-ya) — means "lizard hip."
Saurolophus (sawr-OL-o-fus) — means "lizard crest," 74, 77; illus., 65, 70
Sauropoda (sawr-o-PODE-a) — means "lizard foot."
Sauropterygia (sawr-op-tair-I-jee-ya) — means "lizard fin."
Scaphognathus (skaf-o-NAY-thus) — means "scoop jaw," 101; illus., 100
Scelidosaurus (skel-EE-doe-sawr-us) — means "rib lizard." Illus., 81
Scleromochlus (sklair-o-MOKE-lus) — means "tough lever," 33; illus., 32
Scolosaurus (SKOLE-o-sawr-us) — means "thorn lizard," 84, 86; illus., 83
Seymouria (see-MORE-ee-ya) — means "of Seymour," referring to the town of Seymour, Texas, where this reptile was found, 23; illus., 24
Sphenacodon (sfeen-AK-o-don) — means "wedge tooth," 27, 28; illus., 29
Squamata (skwam-A-ta) — means "scaly."
Stegoceras (steg-O-sair-us) — means "covered horn," 77; illus., 79
Stegosauria (steg-o-SAWR-ee-ya) — means "covered lizards."
Stegosaurus (STEG-o-sawr-us) — means "covered lizard," 62, 78, 81, 82, 84; illus., 80
Stenopterygius (sten-op-tair-I-jee-us) — means "narrow fin," 104; illus., 101
Struthiomimus (strooth-ee-o-MIME-us) — means "ostrich imitator."
Styracosaurus (stie-RAK-o-sawr-us) — means "spike lizard," 89, 92; illus., 88
Synapsida (sin-AP-sid-a) — means "beside arch," referring to the single opening in the skull behind the eye.
Syrmosaurus (SEER-mo-sawr-us) — means "trail lizard," 84, 86; illus., 84

Tanystropheus (tan-ee-STROFE-ee-us) — means "long vertebrae," 30, 32; illus., 30
Thecodontia (theek-o-DON-tee-ya) — means "container teeth."
Therapsida (thair-AP-sid-a) — means "beast opening," referring to the skull opening like that of mammals.
Theropoda (thair-o-PODE-a) — means "beast foot."
Thescelosaurus (THESS-el-o-sawr-us) — means "marvelous lizard," 61; illus., 60
Titanosaurus (tie-TAN-o-sawr-us) — means "large lizard," 53; illus., 54
Torosaurus (TOR-o-sawr-us) — means "piercing lizard," 93; illus., 92
Trachodont (TRAK-o-dont)—means "rough tooth," 67
Trachodon (TRAK-o-don) — means "rough tooth," 73
Triceratops (tri-SAIR-a-tops) — means "three horn face," 11, 86, 87, 93; illus., 94
Trinacromerum (tri-nak-roe-MAIR-um) — means "three long parts," 111; illus., 107
Troödon (TRU-o-don) — means "wound tooth," 77; illus., 79
Tsintaosaurus (t-sin-TAY-o-sawr-us) — means "China lizard," 75, 123; illus., 65, 75
Tylosaurus (TILE-o-sawr-us) — means "knot lizard," 109; illus., 107
Tyrannosaurus (tie-RAN-o-sawr-us) — means "tyrant lizard," 11, 36, 42, 44, 46, 48, 67, 74, 84; illus., 49

Varanosaurus (var-AN-o-sawr-us) — means "varanus lizard," 27, 28; illus., 28
Varanus (var-AN-us) — means "lizard."

Yaleosaurus (YALE-ee-o-sawr-us) — means "Yale lizard," 52; illus., 55

Addenda

To Classification of Vertebrate Animals (124-125)
Order Eosuchia (primitive diapsid reptiles) *Champsosaurus*
Order Rhynchocephalia (primitive lizard-like reptiles) *Sphenodon* (tuatara)

To Glossary and Index of Scientific Names (125-128)

Champsosaurus (CHAMP-so-sawr-us) — means "crocodile - lizard" in reference to its appearance.
Eosuchia (Ee-o-sook-ee-a) — means "dawn - crocodile." Primitive diapsid reptiles.
Rhynchocephalia (rink-o-sef-ay-lee-ya) — means "snout - head." Primitive lizard-like reptiles.
Sphenodon (sfeen-o-don) — means "wedge - tooth."

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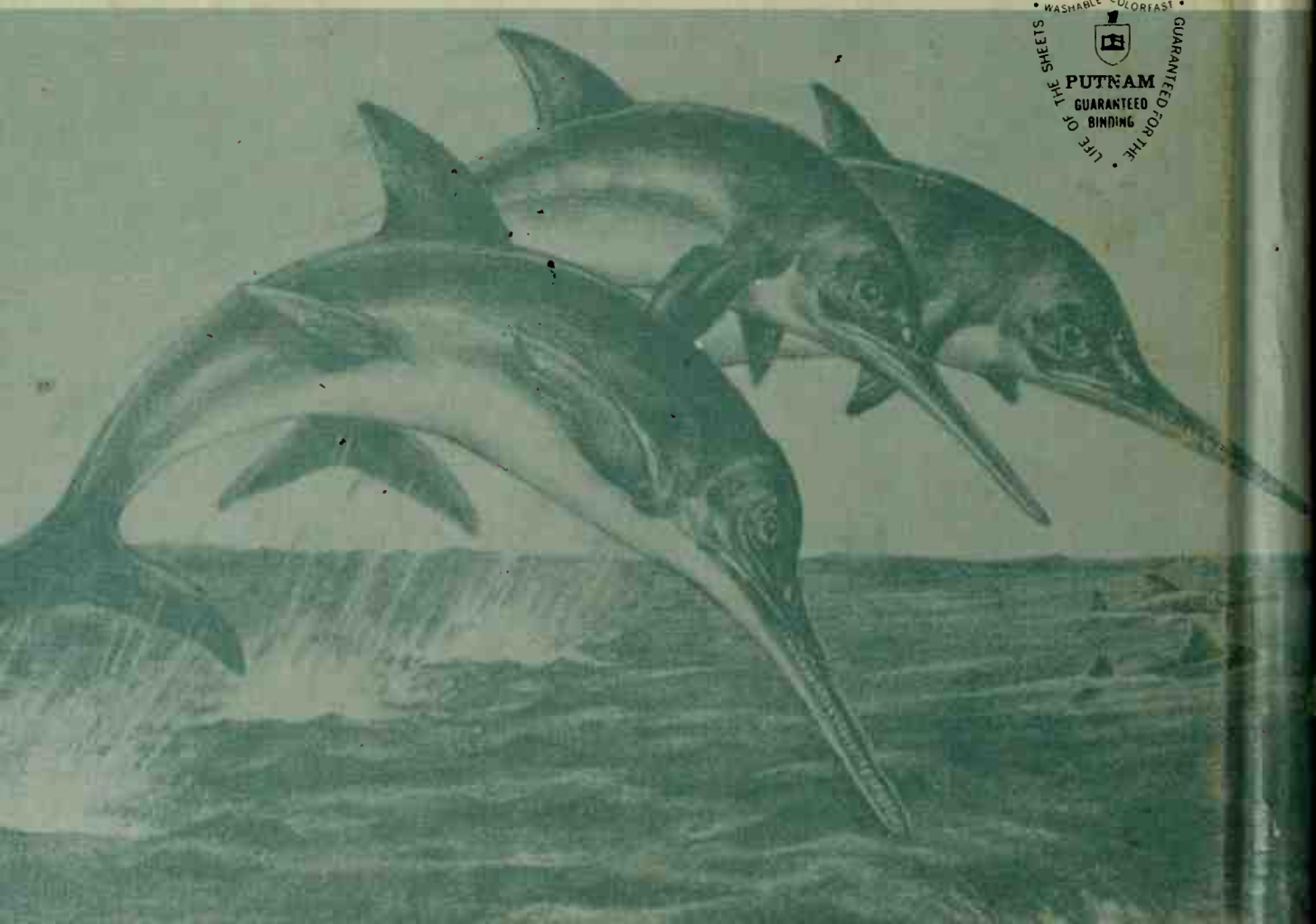

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